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NORTHWEST SCIENCE

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Vol. XVI No. 1

Published by

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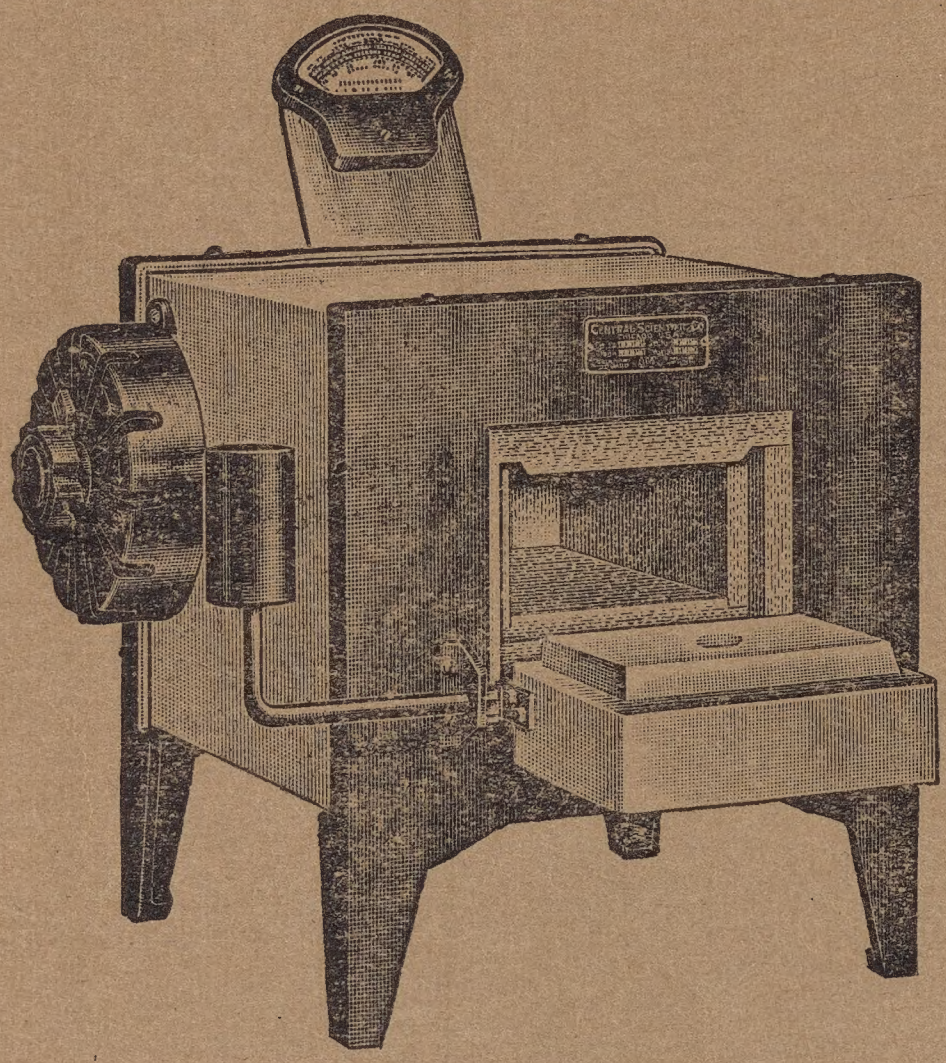

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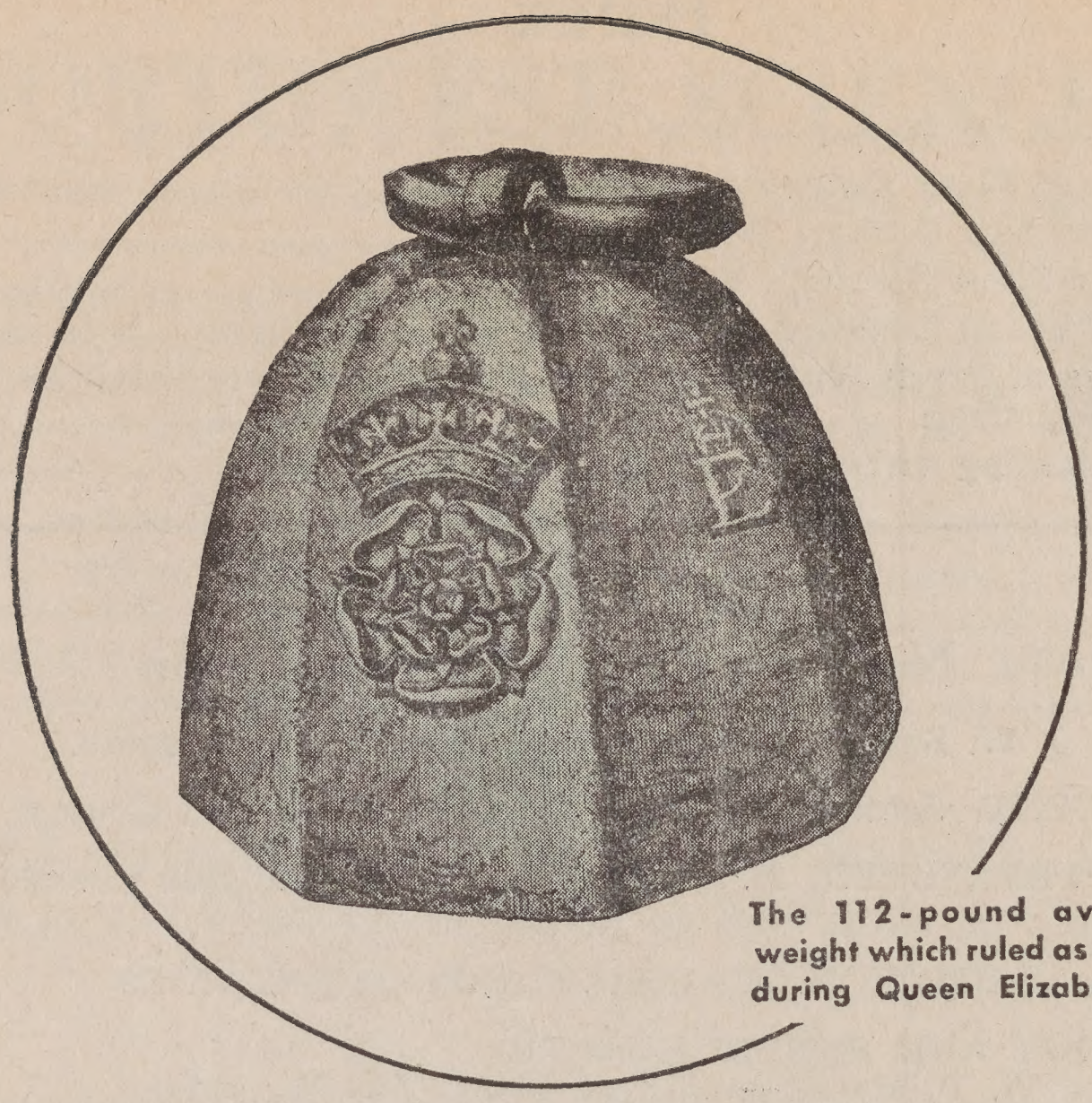

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Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes 1 to XV, 1927 to 1941, each $1.25.
All Fifteen Volumes, $15.00

Editor, Otis W. Freeman, Cheney, Washington

VOL. XVI, NO. 1 FEBRUARY, 1942

1942 Meetings

The 1942 meeting of the Northwest Scientific Association will be held at the Davenport Hotel in Spokane on December 28 and 29.

To Members of the Northwest Science Association

This is a plea for help. The dues of our Association are only $1 per year. Our income is expended for the moderate costs of administration, the publication of "Northwest Science," and the awarding of small grants in aid for worthy research projects largely regional in character. At the December Councillor's meeting an increase in membership fee was urged, but the majority of the Councillors felt that during the war emergency this might tend to discourage members. At the annual meeting during each of the last two years, dues have been collected, as well as voluntary contributions to the research fund. There are more calls than ever for grants in aid and the publication costs of "Northwest Science" are increasing. It has been the practice to mail "Northwest Science" to all members in arrears in their dues—sometimes in arrears as much as two or three years.

The help and support of each individual are more valuable to the Association in the long run than money; yet, if the Association is to remain strong and eventually through its fostering research to play its part in the postwar reconstruction period, particularly in the Northwest, it must remain an active association even during the war years. The demands upon the pocketbook of each of us are already great. They will undoubtedly increase. Yet through it all democratic America must support its vital institutions. In most cases nonpayment of dues is an oversight. If you are in arrears and can't afford to pay the back dues, pay up your current dues for the year 1942 and enter again into active membership. If you care to make a modest voluntary contribution in addition for research fund, you might also include that. Send your check to Dr. H. F. Raup, our new Secretary-Treasurer, Eastern Washington College of Education, Cheney, Washington.

The Northwest Scientific Association maintains a necessary bond between the scientists, oftentimes separated by great distances, in this region. As time goes on, there will be increasing need of closer group action among scientists if they are to play their part in the economic, educational, and industrial development of the Northwest. The Association is already strong. Let's keep it strong—yes, let's make it stronger—during the war years.

J. W. SEVERY, President.

MAR 12 1942

IN MEMORIAM

E. A. BRYAN —— H. V. CARPENTER —— F. O. SMITH

Last November death claimed two men who for more than forty years were closely associated in educational, scientific, and civic affairs in the Pacifc Northwest—Enoch A. Bryan and Hubert V. Carpenter. Dr. Bryan, who had long been in poor health, died November 6, 1941; nine days later he was followed by Dr. Carpenter, who had been ill for several weeks. Both men had belonged to the Northwest Scientific Association since its organization and both had appeared as invited speakers at general meetings of the association, both being active in section meetings or in other ways that helped the organization.

Last July another active member of the association, Prof. F. O. Smith, psychologist at Montana State Univehsity, died at Missoula.

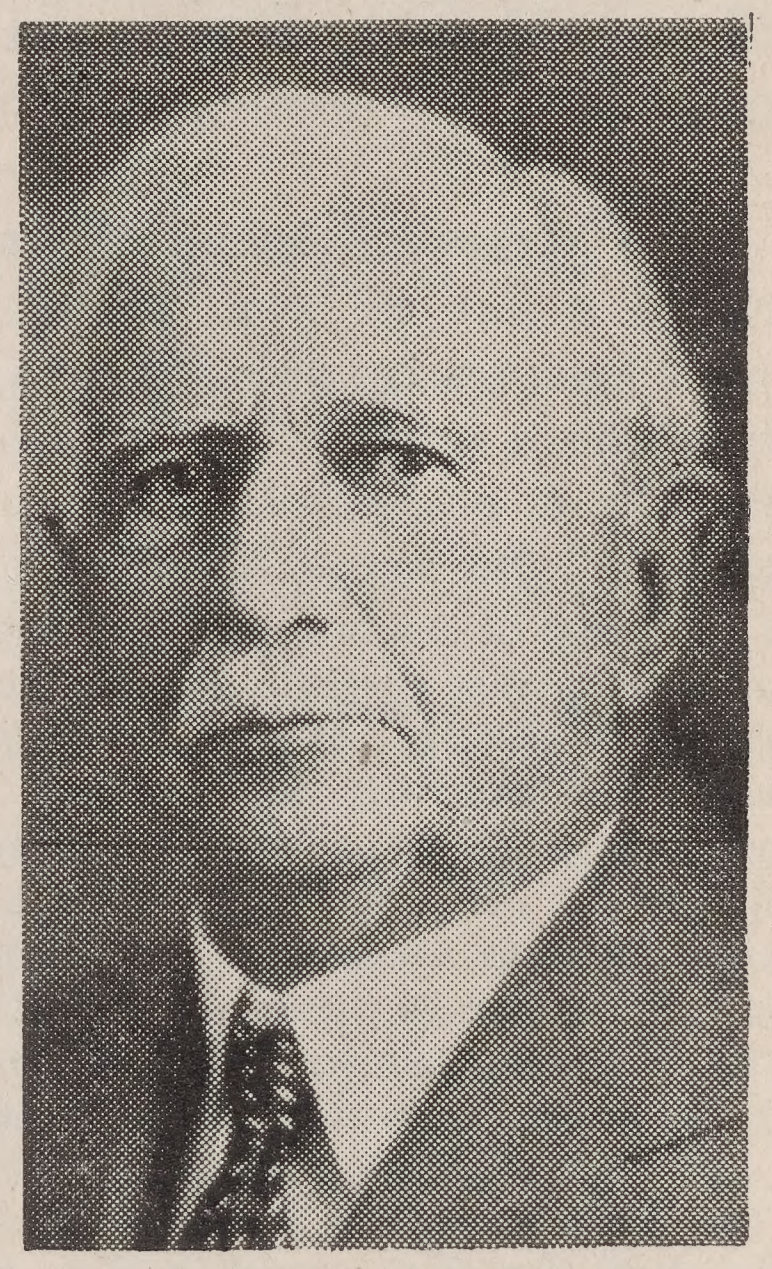
ENOCH ALBERT BRYAN. Dr. Bryan, from 1893 to 1916 served as president of the State College of Washington. He was the third president of the institution, his predecessors having served for very brief periods. Under his direction, the college grew from a very small, scarcely organized institution to a college that was recognized as one of the outstanding land-grant colleges of the country. During his regime there was a notable material expansion, many buildings being constructed and the student body increasing tenfold.

Dr. Bryan was recognized not only as the guiding genius of the State College during its formative period, but was regarded as one of the outstanding leaders in the field of advanced education in the United States.

Dr. Bryan left the State College to take the post of commissioner of education of the state of Idaho, which he held until 1923. At that time he returned to the State College of Washington as research professor in economics and president emeritus.

Born in Bloomington, Indiana, May 10, 1855, Dr. Bryan was graduated from the University of Indiana in 1878 and received his master's degree from that university in 1884. After teaching three years in the school of Jefferson County, he became superintendent of schools in Grayville, Illinois. He became president of Vincennes University in 1882, serving in that capacity until 1893 when he resigned to come to Washington.

The master's degree was conferred upon Dr. Bryan by Harvard Univer-



E. A. Bryan

sity in 1893. He was granted the LL.D. by four institutions: the University of Indiana, 1920; the State College of Washington, 1929; Monmouth (Illinois) College, 1902; and Michigan State College, 1907.

Dr. Bryan was the author of several books, among them, "A History of the State College of Washington;" "Occident Meets Orient, or, The Advent of the Railroads into the Pacific North-

west;" and "The Mark in Europe and America."

Dr. E. O. Holland, who succeeded him as president of the State College of Washington, said of Dr. Bryan: "He has been recognized for more than one-third of a century as one of the leaders in the field of higher education in this country. On many occasions he was called upon to interpret the philosophy of the great Morrill Act which enabled the states to establish institutions of higher learning which would lend important service to agriculture, industry, business, and the various technological fields. These institutions have revolutionized university education in America and have also profoundly affected the curricula and objectives of higher education in other parts of the world, especially in Western Europe.

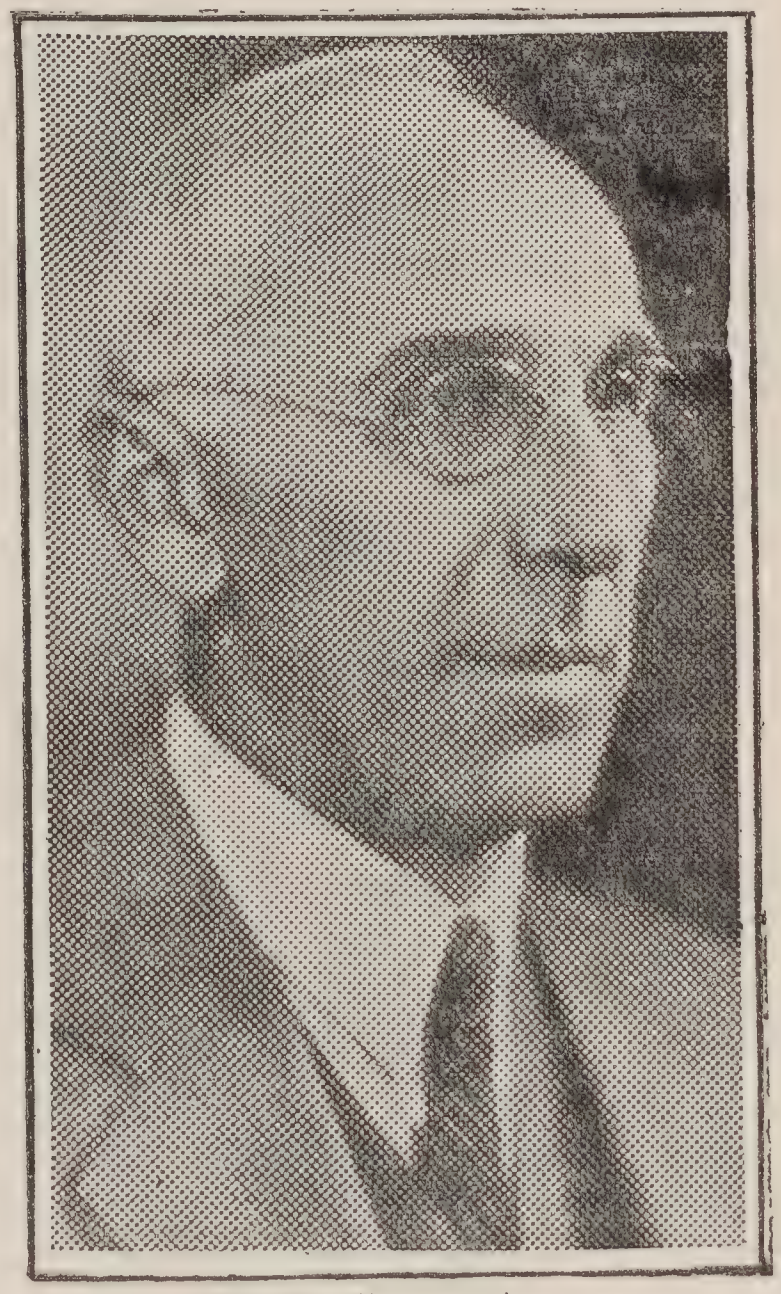
"The people of Washington are the beneficiaries of his unselfish labors and sane and courageous leadership. The State College is today recognized as one of the great land-grant institutions of America and this standing is due largely to the dreams and labors of Enoch A. Bryan."

HUBERT VINTON CARPENTER. Dean Carpenter came to the State College in 1901 as assistant professor of electrical engineering, advancing to professor and head of the department of mechanical and electrical engineering in 1915. In 1917 he became dean of the college of mechanic arts and engineering. In 1935 he was granted leave of absence to act as consultant for the Pacific Northwest Regional Planning Council.

Dean Carpenter's activities covered a wide range of interests. He was well known in the field of engineering where he was a recognized authority on electrical transmission and engineering law. He had appeared in many cases as expert witness and often served as consulting engineer for power companies in this area.

Known as the father of KWSC, Dean Carpenter resigned, built, and assembled the original equipment. He was the first program and technical director and helped secure the station license. Dr. Carpenter was a member of the national committee of the American Institute of Electriacl Engineering on professional ethics, fellow and regional vice president of the Institute, member of the Society for the Promotion of Engineering Education, and a member of the American Society of Mechanical Engineers.

Dean Carpenter wrote a number of important bulletins and made numerous contributions to technical and scientific journals. His textbook, "Electrical Transmission and Distribution of Power," published in 1939 is used as a college text.



H. V. Carpenter

Dean Carpenter was a faculty member of the Pacific Athletic Conference and served as its president. His being a patent attorney is further proof of his versatility. He was one of the founders of the Pullman School of Re-

ligion and was also its president. He was a member of Tau Beta Pi and Sigma Tau, engineering honor societies, Phi Kappa Phi honorary, Sigma Xi, scientific honorary, and Theta Xi, social fraternity.

Dean Carpenter was for many years trustee of the Pullman Methodist Church, was a member of the city council, and served as mayor of Pullman for two terms.

Dean Carpenter was born at Thomson, Illinois, January 29, 1875. He was graduated from the University of Illinois in 1897 and received his master's degree from that institution in 1899. He was granted the LL.D. degree by the State College of Washington in 1938.

DR. FRANKLIN O. SMITH—Dr. Smith, Chairman of the Department of Physchology and Philosphy at Montana State University, died at his home in Missoula on July 13, 1941. Dr. Smith had long been a member of the Northwest Scientific Association, active and earnest in associaton affars and enthusastic in his special field.

Dr. Smith did his undergraduate work at Iowa State University, where he received his Bachelor's degree in 1906. He also continued his advanced studies at Iowa State University and received his Master's degree there in 1907 and his Doctorate in 1912. After brief teaching experience in Utah, Dr. Smith joined the Montana faculty in 1915, at which location he continued to teach until his death.

Dr. Smith early attracted attention by his research in psychology, which he continued almost to the time of his passing. Dynamic, and a man of ideas, he was a fine teacher as well as a leader in the faculty. Despite teaching loads which were often heavy, he found time to maintain research, particularly in the modern aspects of psychology. His death is a loss to the University and to the group of scientists in the Northwest. His smile and his warm support of intellectual things will be missed by all who knew him.

SOME ASPECTS OF PLANT NUTRITION

By FLOYD W. GAIL
University of Idaho, Moscow, Idaho

Plant nutrition is one phase of plant science that is very important in crop or plant production, as well as determining the constituent food value of the crop or plant for human and animal consumption. Even when specialists are brought together and their information is pooled, there are still a number of missing links. If this still is true when information is pooled, it is doubled many times when one is working independently. The subject is very involved. The anatomical structure of the various economic plants varies tremendously. The extensiveness of the root system, the aggressiveness of the plant in its absorbing minerals, the length of the growing season, the inherent disease resistance, and the general hardiness are all variable from species to species. Furthermore, the soils which serve as the plant media vary as to parent materials, degree of maturity, type, exchange capacity, reaction, and organic content.

In the light of present knowledge plant nutrition does not always appear to be strictly logical in its behaviorisms. For instance, sodium and potassium are very similar as to their chemical reactions, valence, and general chemical and physical characteristics. They are so similar that they were placed side by side in the periodic system. Yet, potassium is one of the primary nutrient elements and sodium is of little or no recognized importance to the plant. It has been found that sodium can be substituted for about one-half of the potash in certain crops but cannot be substituted entirely for potash.

*Plant assimilation presents some very interesting problems along these lines. Du Buy says that the various elements of plant food are taken up or absorbed in four ways, namely:

1. As a result of concentration gradient (diffusion).
2. Poorly ionized substances taken into the plant as a result of water uptake.
3. Polar uptake. (The ionized substances are attracted by the opposite charge of root parts.)
4. As a result of respiratory processes. (This material is taken up against the concentration gradient.)

This fourth point has not long been accepted but seems to have been established recently by Hoagland, Arnon, and Shull.

Since energy is actually utilized in the assimilation process, the air-water relationship within the soil would come in for consideration. A poorly drained soil, for instance, would contain more water, correspondingly smaller quantities of oxygen. Therefore, it would seem that the efficiency of the absorption of plant food elements would be greatly reduced in soils which are poorly drained. General observations in the field bear out this point

Certainly the amount of plant food elements absorbed depends a very great deal upon the rate of translocation within the plant which, in turn, is greatly affected by climatic conditions, Translocation is greatly affected by time and intensity of exposure to light and the prevailing temperature.

In connection with plant food absorption by respiratory processes, Seifriz calls attention to the fact that the alga **Valonia,,** which lives in sea water, contains potassium in concentration 40 times that of the sea water surrounding it. On the contrary, the sodium content of that alga is only one-fifth that in the sea water. Furthermore, **Halicysis,** which is a close relative of **Valonia,** stores more sodium than potassium. Some investigators attempt to explain this differential absorption of the several elements on the basis of polar attraction, valence, and size of molecule.

*This term is used here to express incorporation within the plant.

There is a considerable number of conflicting theories offered as explanations. In regard to the valence theory, soils in which the calcium content was very minute, whereas the sodium content was very high as a result of having been subjected to sea water, have been analyzed. This was true in spite of the fact that calcium has a valence of two while the sodium has a valence of only one. This phenomenon in the soil was probably brought about by the greater activity, including polarity, of he sodium and perhaps, to a certain extent, by the mass action. This does not necessarily prove that those elements would behave similarly in so far as plant absorption is concerned, but it does show that even in chemical reactions other factors than valence must be taken into consideration. It would be all the more true in biochemical, i. e., physiological reactions.

The theory of the size of the molecule still has considerable backing but Seifriz calls attention to the fact that four hexose sugars—glucose, galactose, fructose, and mannose—are the same molecular size, but are absorbed at different rates. Glucose is used in respiration and, therefore,, is used in considerable quantity. It is utilized within the plant fairly rapidly and is manufactured fairly rapidly in order to maintain an equilibruim. On the other hand, mannose is not used rapidly and appears to be manufactured less rapidly.

Regardless of how the plant food elements are absorbed by the plant there are a number of disturbing factors which should not be overlooked. Certain plant diseases bring about anatomical changes which, in turn, affect permeability. Furthermore, the concentration within the soil solution of a cation and the nature of the anions combined with it affect the rate of absorption of the cation concerned. Ayres of Hawaii recently showed that both ammonium and potassium absorption were increased as the calcium content of the soil complex was increased. Furthermore, the absorption of both ammonium and potassium was greater when sulphates constituted the anions rather than when chloride constituted the anions of those elements.

Perhaps if we better understood the soil-plant relationship, none of its behaviorisms would appear so illogical. The information is incomplete at best and the realization of mutual benefit in pooling all available information should serve to stimulate the various specialists of plant science in a cooperative research program.

Role of Nutrients and Accessories

It is known today that optimum growth of plants is obtained only when there are available varying amounts of from 14 to 30 elements. Fourteen of these are essential to the growth of most if not all green plants. Each of 16 other elements has been demonstrated to enhance the growth of one or many species.

Little is actually known of the role of each element other than those which become the substance of cell walls, protoplasm and food reserves. Certain elements influence the osmotic pressure, permeablilty, and acidity of protoplasm, the hydration of colloids, and act as antagonizers or catalysts.

In addition to the proper complement of nutrient elements complex organic substances other than foods may be necessary for the optimum growth of plants. Predominant among these accessory substances are thiamin (vitamin B-1) and auxins. Most, if not all, green plants are capable of elaborating these accessory substances, but the growth of certain species is claimed to be improved by the addition of such substances to the substrate on which these plants grow. Accessory substances possibly function in the enzyme-coenzyme systems and in maintaining meristematic activity.

Any substance which is essential to

the optimum growth of a plant may be considered a nutrient. Carbon, hydrogen, oxygen, and nitrogen are synthesized into foods from which the plant builds its body and obtains energy, and are the plant nutrients accumulated in largest amounts. Since green plants obtain carbon, hydrogen, and oxygen from the soil and air as nonmineral compounds and their functions in metabolism receive so much attention in other phases of plant physiology, they are here omitted from discussions of essential nutrients.

Our present knowledge of the nutrient requirements of plants is based upon results obtained by growing them in water culture, sand, and soils, and by culturing excised plant parts in synthetic media. The first attempts to grow plants in water culture probably were those of Woodward in 1699 in which he grew plants in rain, spring, river, and distilled water. The use of water cultures was revived in 1860 by Sachs and Knop, and during the period from 1860 to 1910 the necessity of potassium, phosphorus, calcium, sulphur, magnesium, iron and combined nitrogen was established. These now constitute what are known as the major elements because of the relatively large amounts required for plant growth. Nitrogen, phosphorous, sulphur, calicum,, and magnesium are incorporated into the organic matter that makes up the plant body. Calcium and magnesium counteract the toxic effects that are exhibited when a proper balance is not maintained; calcium also neutralizes organic acids, while magnesium seemingly serves as a carrier of phosphorus. Iron is thought to catalyze respiration and the synthesis of chlorophyll. Cell division is inhibited by a deficiency of phosphorus or potassium. Phosphorus is essential in the respiration of sugars and probably combines with them to form more readily oxidizable compounds. Potassium catalyzes nitrate reduction and functions as a catalyst or condensing agent in the syn'hesis of carbohydrates, fats, and proteins, possibly through its effect on enzyme activity. It has been suggested that the effect of potassium may be due, in part, to its radio activity. Improper potassium nutrition apparently renders some plants more susceptible to fungus diseases. Sulphur produces certain formative effects in plants, notably; increased root systems, and improved vigor and color. Whether nitrogen exerts effects other than those of the proteins and other organic compounds of which it becomes a part is not known, but the amount and the form of nitrogen in the plant have very pronounced effects upon the rate and type of growth, upon food reserves, and upon reproduction.

During the present century and principally within the last 20 years, it has become evident that mineral elements other than those just cited are essential to plant growth. These elements are referred to as the "rare" or minor elements because of the small amounts of them required. The proof of their necessity required the perfection of culture media and containers which would not supply them to plants in quantities sufficient for optimum or near-optimum growth. With the improvement of techniques, the number of essential minor elements may be increased. It is generally accepted that manganese and boron are essential to the growth of all green plants, and zinc and copper are required by most, if not all, species. Evidence indicates that silicon, chlorine and aluminum are probably required by many plants.

Less is known concerning the role of minor elements than of major elements. The effects of a deficiency of boron on the growth and general appearance of plants vary with the type of plant, its age, and its cultural environment. Boron is said to function in regulating growth and metabolism, which is an ego-saving manner of saying, "We do not know." The same admission must be made concerning manganese, zinc, and copper. The toxic effects of too large amounts of these elements and the varied responses to them of the same plant species under differ-

ent cultural conditions present more immediate and important problems than do their roles.

Sodium apparently can be substituted in part but not entirely for potassium and was thought to have been demonstrated conclusively to be essential only to marine algae; but now Mullison, Purdue University, finds sodium may be essential as well as potassium. Barley seedlings growing in sand were given nutrient solutions in which sodium was substituted for potassium and which contained varying relative amounts of phosphates, nitrates and sulphates. No effects of the interrelations of these ions other than those already reported in previous publications were observed in the absence of potassium. The lack of potassium was manifested slowly. Other plants given nutrient solutions lacking both sodium and potassium became chlorotic and the leaf tips died back very rapidly. Further investigations showed that this was not due to the toxicity of some other ion in the absence of potassium. One-half of another group of barley seedlings were supplied with amounts of potassium varying from none up to 180 p. p. m.. They were far more vigorous when supplied with sodium in addition to the potassium than when supplied with potassium alone. Above the level of 35 p. p. m. the plants were apparently not improved by the addition of sodium. Plants grown on sodium alone were able to persist for some length of time; in fact, much longer than those grown in the absence of both sodium and potassium. To get the clearest picture of potassiuum deficiency, sodium as well as potassium must be excluded from the nutrient solution. Silicon increases the ability of a plant to utilize phosphorus or renders phosphorus more readily available. It is doubtful that any plant has been grown in the absence of silicon, chlorine,, or aluminum. The difficulty of elimina'ing these elements from cultures makes the demonstration of their necessity in minute amounts an extremely difficult task and, until their necessity is demonstrated, little can be determined about their possible roles. Beneficial effects on the growth of certain plants have been claimed for the addi ions of small amounts of each of the following elements: iodine, selenium, barium, strontium, titanium, thallium, vanadium, arsenic fluorine, rubidium, and nickel.

In addition to a plant's requirements for mineral elements and combined nitrogen, it is now suspected that complex compounds other than carbohydrates, fats, and proteins are essential to the optimum growth of plants and the normal behavior of plant protoplasm. Such a concept has been prompted by the results of attempting to culture excised parts of green plants in synthetic media and studies of the requirements of bacteria and fungi. W. H. Robbins, P. R. White, V. B. White, James Bonner, F. T. Addicott, Bartley-Schmidt and others claim that vitamin B-1 or its components, thiazole and pyrimidine, are required by the protoplasm of green plants and most fungi. According to Robbins and Goddard, thiamin functions in the enzyme-coenzyme system in plant respiration. Addicott has demonstrated that continued meristematic activity of certain roots occurs only in the presence of thiamin.

While the necessity of vitamin B-1 for the growth of excised plant parts does not in itself indicate that a plant growing in soil needs external sources of the material, it has opened a new field of investigation and is a complete reversal of the belief that, while vitamins were made by plants, they were of benefit only to animals. Attempts to demonstrate that the addition of vitamin to the cultural media is beneficial to green plants have yielded con'radictory results. Bonner has demonstrated that vitamin B-1 improves the growth of certain plants, especially **Camelia,** when supplied to the soil in which the plant grows. Kraus reviewed evidence at the 1940 meeting of the Society of Agronomy that green plants do not profit from the addition of thiamin to

media in which they are grown. While the controversy is too young to permit a decision, there is little doubt that the concept of adding vitamin B-1 to the soil as a panacea for nutritional evils has received too much publicity. Other accessory substances suspected of being essential to optimum plant growth and under investigation at present are vitamin B-6, nicotinic acid,, absorbic acid (vitamin C), and certain amino acids.

An entrely different group of chemicals is represented by the so-called auxins, which are both growth-promoting and growth-inhibiting in their effects. Certain auxins, while effectve in inhibiting the development of adventitious roots, nevertheless do exert formative effects on the development of the plant body and help prevent the abscission of leaves and fruits of some plants.

Among the current advertisements may be found one which runs "Buy vitamin B-1 and experiment with plants —plant physiology is the world's most fascinating hobby." Of course, in riding a hobby, and a hobby horse, we are just having fun and not going anywhere. Those of us who are more seriously interested in plant physiology may not yet boast of surpassing achievement in the field of plant nutrition. The researches which have sought to explain how plants grow have revealed increasing complexities. The wonder is that in the midst of all these complexities plants are able to grow. Moreover, insofar as we are able to judge, plants do not seem to worry about the possibility of finding 0.001 p. p. m. of thallium or some other element toxic at very low concentrations The plant physiologists, on the other hand, do wonder and worry about these things. We may say that in the meantime they have become more or less reconciled to slow progress in ferreting out the secrets of plant growth. There is little basis for conceit among us; we can only report progress, and there will be innumerable unsolved problems in plant nutrition to intrigue future generations.

Attention may be directed at this time to a new approach in the inorganic nutrition of plants. For many years 10 chemical elements sat enthroned in the textbooks as the basic or essential ingredients of plants. As pointed out this list has been extended in recent years and it has come to be recognized that elements may serve when present in very small amounts. Some of them probably act as catalyzers or approach the category of hormones. Coincident with these developments there has come the recognition of "deficiency diseases" in plants, each deficient element, as boron, magnesium, manganese, zinc, etc., giving rise to a more or less specific set of symptoms. Not only do these symptoms often simulate virus or leafspot infections but in a number of instances a deficiency disease has been evidenced as predisposing plants to attack by fungi. In this way an unrecognized nutrient deficiency may confuse the plant pathologist. Carrying the relationship one step further, there is the important possibility that plant resistance to disease may be enhanced through a more adequate recognition of the roles of the minor elements. On the other hand, there is much evidence of interplay and balance among the nutrient elements and on this account it may become possible to establish roles for the elements as individuals Moreover, the amounts of some elements seemingly necessary for plant growth are so small as to render research exceedingly difficult and expensive. To work out the dificiency symptoms on any crop for a half-dozen of minor elements is no easy taks, and in only few instances has it been accomplished. On this account a recent departure from the traditional approach to the minor element problem is of particular interest.

The use of spectrographic techniques used first by Bunsen with plant tissues revealed the presence in plants of chemical elements in amounts too small to be detected by chemical analyses and the list of elements taken up by plants has been greatly increased.

The use of fractional crystallization techniques with expressed plant juices proved still more sensitive and revealed the presence of virtually all chemical elements in plants. It may be recalled that in the previous century a great deal of research was directed to the chemical analysis of plants, in part upon the assumption that, with selective absorption, plants took in what they needed. In a similar way it has been reasoned recently that these elements in great variety, being constituents of plants, might well be functional. In addition there has been the seeming certainty that if all elements are present in a nutrient solution no deficiency symptoms will develop. Excluding the common elements taken in from the air or present in all soils, those commonly added as commercial fertilizers, a few insoluble ones and the inert gases, a mixture of various pulverized ores comprising 64 elements was prepared. This mixture is now being tested as an adjunct to the usual N-P-K fertilizers in Experiment Station test plots in about 30 of our states. The results may well be of considerable interest, not only from the practical viewpoint but also in relation to the fundamental concepts of plant nutrition.

With respect to organic radicals in relation to plant growth, caution in regard to vitamin B-1 will be approved and shared by most plant physiologists. The facts are that as yet we have only scattered tidbits of knowledge concerning the organic materials in plants. When certain insects place certain substances in a willow stem the plant immediately sets about construction of an elaborate cone-like structure or gall protecting the insect progeny. When plant physiologists take organic substances and begin to experiment with plants it is true that anything is liable to happen, but at present the usual development is simply the further recognition of the complexities involved in plant growth.

While the foregoing discussion may have created the impression that little is known of the role of nutrients and accessory substances, it should be emphasized that the problem is enormous and cannot be solved until sufficient data have been accumulated and evaluated critically in the light of theoretical research and practical application under field conditions. A more thorough understanding of the role of all nutrients can come only through a close cooperation between the theoretical physiologist and the practical field worker in which knowledge is pooled and each evaluates, tests, and applies information gleaned by the other.

THE STEAM PRESSURE COOKER

By W. V. HALVERSEN*

The steam pressure method of canning has been adopted in homes and factories for the preservation of non-acid foods. The reasons for adopting this method are apparent: (1) it is less expensive because the period of processing is much shorter, and (2) certain heat-resistant bacteria, including the much-dreaded **Clos. botulinum,** can be killed with certainty at the high temperatures obtainable in the steam pressure cooker. The remarkable efficiency of this process for commercial canning is generally recognized. It must be admitted, however, that because of inferior equipment and less efficient operation, home canning by the steam pressure method is not as successful as could be expected. There is no question but that the principle is fundamentally sound, but there appears to be a definite need for research directed toward eliminating those factors which make home canning less efficient than commercial canning.

The pressure gauge is used on almost all makes of household steam pressure canning equipment as the sole means for regulating the processing. Since temperature and not pressure is the sterilizing agent, it appears obvious that a thermometer which gives a direct temperature reading would be more reliable as a guide for the processing of foods. The principal objections to a pressure gauge are: (1) It does not differentiate between steam pressure and air pressure (air may be present because of incomplete exhaust), 2) it may become inaccurate after a period of use, and (3) it is influenced also by altitude. Failure of the operator to recognize the importance of any of these three facts may result in the loss of the advantages of the steam pressure method.

Several writers on the subject of canning have pointed to the desirability of having household steam pressure cookers equipped with thermometers. For example, Stanley and Steinbarger (3) state, "It is desirable, also, to have a thermometer set in the top, so that the pressure can be checked against the temperature." They further state, "Pressure gauges may become inaccurate after a period of use." Tanner (4) writes, "However, good canning practice should provide for a reliable thermometer with which the actual temperature may be determined. This is necessary not only because the atmosphere in the cooker may contain considerable air but because gauges may become faulty by use year after year without inspection and adjustment." Baragar (1) concludes, "The test on fifty-two new and old gauges showed that many gauges being used on pres-

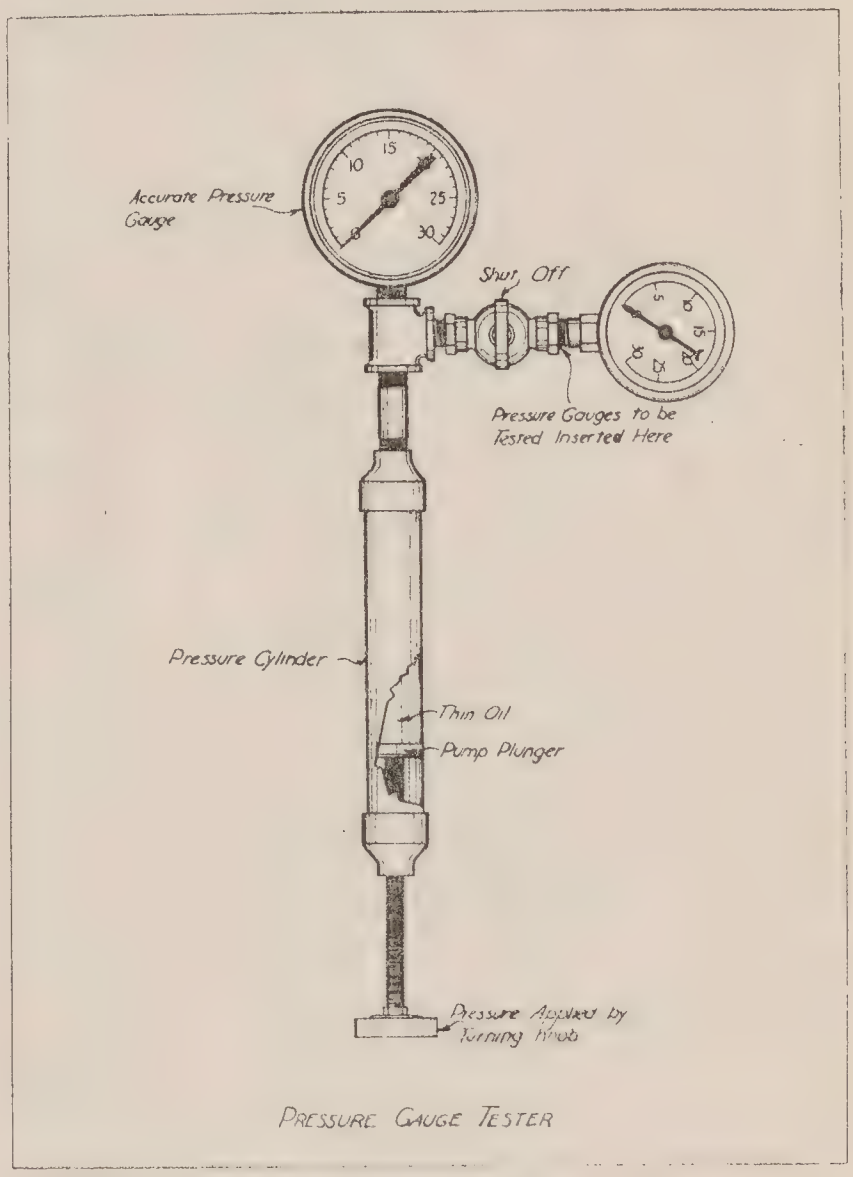


Figure 1.

The author acknowledges the fine work of Mr. Roy Kaylor, machinist at the University of Idaho shops, who made the pressure gauge tester pictured above.

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sure cookers are seriously off-calibration . . ."

It has been the author's observation that the manufacturers of household steam pressure cookers do not generally equip them with thermometers, and the foregoing references substantiate his claim that the pressure gauges supplied commonly become inaccurate after a period of use, which results in spoilage of canned food and exposes the home canner to the perils of botulism and the economic loss of food. It, therefore, appears logical that the manufacturers of steam pressure cookers should voluntarily either equip them with thermometers or develop pressure gauges which are accurate and remain so under use. Improvements should also be made in the design and construction so that entrapped air more readily could be exhausted. Since steam is lighter than the air it displaces, it seems logical that he pecock should be inserted in the container just above the level of the water. It would probably be better if the thermometer were inserted at this point also. Barager (1) suggests the desirability of developing an automatic air-release valve to eliminate the uncertainty of knowing when all the air was out of the cooker. Failure to do this may result in legislative programs warning the home canners of the situation. Such legislation or educational program would be undesirable because it would lessen confidence of the public in the steam pressure canner and retard the universal adoption of this type of equipment.

The degree of inaccuracy of pressure guages is portrayed by the data in Table 1.

For apparent reasons these steam pressure cookers are referred to by number. The names and addresses of the owners, the manufacturers of the pressure cookers and the manufacturers of the pressure gauges have been purposely omitted from the table. However, the group is representative in that the common makes are represented. It is not uncommon to find the pointer on the pressure gauge to be fitted so loosely that it will move freely back and forth so as to vary from one to two pounds without any change in pressure. It is evident from these data that a large proportion of the steam pressure gauges used on household steam pressure cookers are inaccurate. Of thirty-eight representative gauges tested, 14 had an error of two or more pounds, five had an error of four or more pounds and one had an error of five pounds. It is unfortunate that a faulty gauge always indicates a steam pressure greater than that which actually exists within the cooker. This is serious because it follows that the temperature inside the cooker is not as high, and therefore not as effective for processing the food, as the gauge indicates.

Table 2 shows that the relationship of steam pressure gauge reading to temperature is influenced by altitude. The pressure gauge actually measures the difference between pressures inside the chamber and atmospheric pressure outside the chamber, which accounts for the fact that approximately one additional pound of steam pressure must be maintained inside the pressure cooker for each 200 feet of elevation above sea level, in order to maintain a temperature equal to that of steam pressure at sea level. Since all manufacturers of pressure gauges adjust them to read accurately at sea level, it is apparent that increases in altitude would require that the operator must either maintain a higher steam pressure or process the food longer in order to use for canning time tables which are based on sea level. Since the error due to altitude is in the same direction as the inaccuracy of the pressure gauge caused by use, it becomes apparent that the combined errors may become so great in mountain states, where steam pressure cookers are considered most urgent, as to defeat the purpose of the steam pressure method.

Table 2, page 16 shows the gauge pressure corresponding to specified process temperatures at various altitudes.

TABLE 1

Tests on Household Pressure Cooker Gauges

Number	Years cooker has been in use.	Elevation at which cooker is used.	Reading of pressure gauge compared to master gauge at:		
			5 lbs.	10 lbs.	15 lbs.
1	1	2650	5	10	15
2		2650	7	12	17
3	1	2650	6	12	17½
4	15-20	2650	5½-6	10½-12	16½-17
5	2	2650	5	10	15
6		2000	4-5	9-10	14-15
7		4450	5½	11	16
8	2	4450	8	13	18
9	20	4450	3½-5	9-10	14-15
10	18	4450	0-5	5-10	6-10
11	1	4450	5	10	15½
12	20	4450	6	11½	16½
13		4450	5	10	15
14		4450	0	6½	11
			At 20 lbs. pressure registers 16.		
15		4450	5-7½	10-12½	15-17½
16		5950	10	15	20
17		4450	5½-4½	10-11	15-16
18	5	4800	5-6	10-11	15-16
19	3	4800	6-7	11-12	16-17
20	5	5800	8	14	16-19
21	10	5200	6¼	12	17.5
22	1	4900	6	11	16
23	5	4900	6-8	12-14	17-19
24	2	5950	5	10	15
25	1	6000	5½	10½	15½
26	2	6000	6-7	11-12	16-17
27	2	6000	5	10	15
28	2	6000	5-	9	15
29	5	5950	5-6	10-11	15-16
30	1	6000	5-5½	9-10	14-15
31	4	5950	3-4½	8-9	13-14
32	2	5950	5	10-11	16-18
33	5	6000	6	11	16
34	25-30	6000	—	—	—
35	2	6000	6	12	17
36	2	6000	5	10	15
37	1	6000	5	10	15
38	17	1000	6	11	16

Considering that the elevations at which these cookers are used vary between 1000 and 6000 feet, it becomes apparent that one to three pounds' additional pressuure should be allowed, respectively. In the case of pressure cooker No. 20 it would be necessary to have a pressure gauge reading of 11 pounds of steam pressure in order to have a processing temperature equal to five pouunds of steam pressure at sea level and a gauge reading of 17 pounds to secure the equivalent of 10 pounds steam pressure at sea level. The same figures remain virtually true for No. 23.

Baragar (1) states: "Further since the temperatures indicated on pressure gauges are true only when the gauge calibration is correct and readings are being taken at sea level, the use of these temperatuures as a processing guide is misleading and the markings of temperature on pressure gauge dials should be taken with a reliable thermometer.

Testing the pressure gauge to determine its accuracy is a problem which

might naturally be assigned to a mechanical engineer rather than a housewife. The manufacturers of pressure gauges adjust them to read correctly at sea level. No satisfactory method for adjusting each gauge so as to compensate for the effect of altitude has been found. The simplest method for determining whether a certain steam pressure gauge is accurate is to take it off and send it back to the manufacturers. One of the principal manufacturers of pressure cookers makes the following offer: "Send your gauge to ....., regardless of the make of cooker you are using, with only 50 cents. If your gauge is found accurate, we will return it to you, postpaid, with a refund of 25 cents, charging you only 25 cents for handling, packing and postage." It would seem logical to educate users of pressure cookers to have their steam pressure gauges tested each year, and a statement of this type should be included with the directions supplied by the manufacturers of pressure cookers.

The most logical solution would be to equip the cooker with a thermometer so that the pressure gauge could be checked against the actual temperature. Under these conditions there would be little need for the pressure gauge. Time tables for processing would then be tabulated for given temperatures rather than steam pressure readings.

If a mechanical engineer were to test the gauge in the absence of a thermometer, he would probably mount the gauge along with a U-tube filled with mercury (manometer) and determine how high a given pressure reading would force the column of mercury. Such a test could best be made in a laboratory. This would necessitate that the pressure gauge be removed from the cooker and be sent to the testing laboratory. The service would be similar to that offered by the commercial company outlined above. In an elaborate experimental testing set Baragar (1) used a cooker equipped with (1) a mercury thermometer, (2) a copper-constantan thermocouple for measuring temperatures within the cooker (3) a safety valve, (4) an automatic air release valve, (5) a petcock for releasing steam, (6) an opening for the gauge to be tested and (7) a mercury manometer to be used as the standard for comparisons.

Another method which has been used extensively in the home is placing a

TABLE 2
Gauge Pressure Corresponding to Specified Process Temperatures at Various Altitudes

Temp. Deg. F	Sea level	Feet above sea level							Temp. Deg. C.
		500	1000	2000	3000	4000	5000	6000	
200	——	——	——	——	——	——	——	——	93.3
205	——	——	——	——	——	——	0.5	0.9	96.1
210	——	——	——	0.4	0.9	1 4	1.8	2.3	98.9
212	0.0	0.2	0.5	1.0	1.5	2.0	2.4	2.9	100.0
215	0.9	1.1	1.4	1.9	2.4	2.9	3.3	3.8	101.7
220	2.5	2.7	3.0	3.4	3.9	4.4	4.9	5.3	104.4
225	4.2	4.5	4.7	5.2	5.7	6.2	6.6	7.1	107.2
230	6.1	6.3	6.6	7.1	7.6	8.0	8.5	9.0	110.0
235	8.1	8.3	8.6	9.1	9.6	10.0	10.5	11.0	112.8
240	10.3	10.5	10.8	11.3	11.7	12.2	12.7	13.1	115.6
242	11.2	11.4	11.7	12.2	12.7	13.1	13.6	14.1	116.7
245	12.6	12.9	13.1	13.6	14.1	14.6	15.0	15.5	118.3
248	14.1	14.3	14.6	15.1	15.6	16.0	16.5	17.0	120.0
250	15.1	15.4	15.6	16.1	16.6	17.1	17.5	18.0	121.1
252	16.2	16.4	16.7	17.2	17.7	18.1	18.6	19.1	122.2
255	17.8	18.1	18.3	18.8	19.3	19.8	20.2	20.7	123.7
260	20.7	21.0	21.2	21.7	22.2	22.7	23.1	23.6	126.7

Published by National Canners' Assoc. in Bulletin 26L, page 14, April 1939. Used by permission. (2)

maximum temperature thermometer inside the pressure cooker in a can of water and proceeding to heat the cooker just as one would begin to process canned food. Let the pressure rise to 10 pounds. If the pressure goes above 10 pounds, note the highest pressure. reached. Remove the cooker from the heat and let it stand until the pressure registers zero, when it can be opened and the thermometer reading recorded. The mercury should be shaken down and the process repeated at 15 pounds' pressure. The following table shows the temperature in degrees Fahrenheit which correspond with the correct steam pressure at sea level.

TABLE 3

Temperature Corresponding to Gauge Reading in Pounds of Steam Pressure (at Sea Level)

Lbs. pressure per sq. inch	Temp. Degrees Fahrenheit
0	212.0
1	215.4
2	218.5
3	221.5
4	224.4
5	227.1
6	229.6
7	232.3
8	234.7
9	237.0
10	239.4
11	241.5
12	243.7
13	245.8
14	247.8
15	249.8
16	251.6
17	253.4
18	255.4
19	257.0
20	258.8

Observe the steam pressure shown in Table 3 corresponding to the temperature obtained on the maximum temperature thermometer. (Interpolate to obtain fractional pounds pressure), subtract this from the maximum steam pressure gauge reading maintained during the testing process. The difference represents the loss of sterilizing power due to inaccuracy of the gauge plus the altitude factor. For example, if this method showed an error of three pounds at 2000 feet elevation, it would be because of one pound for elevation and two pounds for inaccuracy of the gauge. If, however, a similar error of three pounds was encountered at 6000 feet elevation, it would indicate three pounds error due to elevation and the pressure gauge should be accurate at sea level. A thermometer especially suited to this purpose has been developped by one of the leading manufacturers of such equipment. The principal difficulty encountered in this method is that it requires a suitable source of heat and takes an hour or more to do the testing.

Figure 1 illustrates a simple portable device developed by the author for testing steam pressure gauges. The disadvantages encountered in using this device are (1) it is necessary to remove the pressure gauge from the cooker in order to perform the test, and (2) the master gauge, like the gauge on the cooker, is influenced by altitude. The advantages are that it works very fast and serves well for use in an educational campaign. Since all pressure gauges used on household pressure cookers have the same size threaded base it is

not necessary to have any complicated coupling connections.

The details of construction are so simple that they hardly need explanation. The tester is operated by turning the knurled knob which exerts a pressure on a pump plunger. This plunger is made air tight by a layer of lubricating oil, air pressure is transmitted equally to the master gauge and the gauge to be tested.

SUMMARY

The steam pressure gauge is used on almost all makes of household steam pressure cookers as the only means of indicating the temperature within the cooker. Tests have shown that most steam pressure gauges become inaccurate after they have been in use for several seasons. The inaccuracy is such that the gauge generally indicates a steam pressure greater than that which actually exists within the cooker.

Altitude also influences the relationship of pressure and gauge reading to temperature of the steam inside the pressure cooker. The pressure gauge actually measures the difference between pressures inside the chamber and atmospheric pressure outside the chamber, which accounts for the fact that approximately one additional pound of steam pressure must be maintained inside the pressure cooker for each 2000 feet elevation above sea level in order to maintain a temperature equal to a given steam pressure at sea level.

The error due to inaccuracy of the steam pressure gauge plus the added pressure to be allowed for elevation often combine to create such a large factor that it may entirely offset the advantages claimed for the steam pressure method of home canning.

Several methods for testing the accuracy of steam pressure gauges are outlined. The simplest is to remove the gauge and send it to the manufacturer. However, a simple testing device developed by the author is described.

Several modifications in design of steam pressure cookers are suggested to facilitate the removal of air and to give a true indication of the effective temperature inside.

This study indicates that the temperature control in the steam pressure method of home canning is a problem of such magnitude that manufacturers of this type of equipment should improve their utensils along the lines suggested here in order to guard against botulinus poisoning and to prevent unnecessary waste due to spoilage. Failure to do this must surely result in the adoption of educational or governmental control measures.

The seriousness of the condition of steam pressure cookers tested now in use can be judged by the following data: Of 146 pressure cookers tested 30 pressure gauges were accurate; on 63 gauges the dials were so loose that they would shake back and forth over a range of one pound or more without change in pressure: 31 fluctuated 2 pounds or more and 6 fluctuated 3 pounds or more; 87 were inaccurate to the extent that the dial also showed one pound or more pressure than they should; 42 showed an inaccuracy of 2 or more pounds; 23 showed an inaccuracy of 3 or more pounds; 13 showed an inaccuracy of 4 or more pounds; 3 showed an inaccuracy of 5 or more pounds.

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BORON A MINOR PLANT NUTRIENT

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During the past century, soil chemists centered their interest on three critical elements, nitrogen, potassium and phosphorus and a great industry developed to supply these.

During the past two decades replacement of animal power by farm tractors, introduction of pure synthetic fertilizers, and intensive specialized agriculture on leachy, humid-climate soils have contributed to manifestation of numerous deficiency diseases of crop plants. Part of the boron, sulphur, and iodine may have been roasted out of the basaltic lava from whence came the major soil forming material in the Pacific Northwest.

During the past twenty-five years essential nature of very small amounts of several so-called minor or trace elements gradually became apparent. Various obscure types of malnutrition in plants are prevented or corrected by the presence of traces of such elements as boron, manganese, zinc, copper, molybdenum, or other elements for which essentiality is less definitely established.

For twelve years the Oregon Experiment Station, Soils Department has done exploratory work with minor elements on Oregon soils including an intensive study of the need and value of iodine, followed by boron and recently by manganese investigations. Striking improvement in vigor and yield have been secured from use of boron on leached soils. Use of boron as a fertilizer for alfalfa west of the Cascade Mountains promises to be as profitable as sulphur has been on the more arid basaltic soils to the east thereof. In a former report (Powers, 1937, 1940) (Powers and Bouquet, 1939) the earlier studies with boron in relation to soil fertility in the Pacifc Northwest or Columbia basin were reviewed. The purpose herein is to present a progress report covering continued and recent boron experiments, particularly in Oregon and the Pacific Northwest.

Essentiality: Evidence of the essentiality of boron as a plant food was reported by Agulhon (1910) and Maze (1919) and confirmed by Warington (1923) and Sommer and Lipman (1926). The latter grew large numbers of plants in solution cultures built up from purified chemicals in re-distilled water, and from successixe generations of seed. According to Purvis (1939) 24 states have reported boron deficient areas, and no other plant nutrient has received so much notice in recent literature. Boron, like most of the trace elements, is helpful only at concentrations of the order of one-fourth part per million, while two parts per million in solution may be toxic; so great care is needed in its use. An excess leads to spotting, discoloration and defoliation of lower leaves while a deficiency causes bronzing, then yellowing or blighting of terminal growth.

Effects: A score of plant mal-nutritional symtoms have been related to boron need. Boron has been used in the Columbia drainage area to control "corky core" and "drought spot" in apples; "yellow top" in alfalfa; celery "stem crack" turnip "brown heart"; discoloration of broccoli and asters, and "growth strain" of potatoes. Frequently, marked increase in yield and quality resulted from the treatment.

Boric acid was used by the writer to correct a certain type of chlorosis in water culture experiments as early as 1926. Alfalfa grown in the greenhouse in 2-gallon jars of Springdale and Mission soils from Stevens County, Washington in 1936 developed yellow top before the third cutting. Two hundred cc of solution containing 1 part per million of boric acid corrected this in a few days. The yellow top re-appeared as the plants approached maturity for the fifth cutting. Boron

promoted blooming and branching of alfalfa and should aid longevity. Similar response was obtained the same season in British Columbia by McLarty (1936).

Good control of beet canker was secured with 30 pounds of borax an acre in experiments started by Powers and Bouquet in 1937, perhaps for the first time.

Celery stem crack has been controlled by use of 20 pounds an acre of borax the past 4 years in experiments in cooperation with Professor A. G. B. Bouquet. Little leaf of stone fruits near The Dalles was controlled more completely when borax was included with the zinc spray. Boron is now rather generally used in Hood River Valley to control corky core, following results of McLarty (1936). Potato growth strain and cauliflower discoloration have been corrected in Oregon experiments. Chemical determinations show unfavorably low boron content in soils, waters and vegetation in affected areas. Use of boron in such areas has increased the boron content of plants and raised the chlorophyll and the vitamin A contents as much as 50 per cent. Standards are being developed for boron content of normal leaves.

Possible Functions: Boron appears to give elasticity to the plant cell membranes and to aid cell division (Johnson and Dore, 1928); seems to regulate respiration, lessen effect of drought, and has improved keeping quality of apples and prunes (Roberts, 1940) and prevents swelling and blocking of roots (Sommer and Sorokin, 1928) and pollen tubes (Denis and O'Brein, 1937); Boron prevents breakdown of conducting tissues (Warrington, 1923); is important in nitrogen metabolism and aids development of nodules and nodule bacteria (Brenchley and Thornton, 1925; Boron affects carbohydrate translocation (Johnson and Dore, 1928) and pectin formation and amount of calcium in tissues. Eaton (1940) reported boron to be essential to formation of auxin in plants. Goldsmith (1932) reported boron essential in metabolism of brown algae. Boron is a constituent of animal tissues (Bertrand, 1912).

Results of Field Experiments: During four years three dozen trials with boron have been conducted on 24 soil types including 236 plots. Also material has been furnished the past 2 years to two dozen County Agents for demonstration tests. Use of boron in the Great Basin and in Southern Oregon has been ineffective and in field trials control of beet canker has not affected total yield very consistently so the data are omitted. Increases in alfalfa yields have been as large as two tons an acre a season. A single application of 40 pounds an acre of boric acid on Willamette loam at Hagg Brothers farm gave a total increase in yield of some 7 tons alfalfa and yellow top has not re-appeared after 4 years. The increased yield occurs particularly with old meadows and dry weather cuttings. Legume crops are relatively good indicators of boron need. Bountiful beans in the greenhouse make quick growth and yield goodly amounts of leaves, stems and pods.

Some very profitable responses have been realized from horticultural and field crops. While there is an indicated loss from use of boron on some small fruit crops the second year after treatment there was some increase in cane size and friut yield. Grass and small grain have relatively low boron contents, yet response to boron has been observed with these crops. Schropp and Aren (1940) found boron essential for formation of barley kernels.

The grasses in mixtures may receive indirect benefit from legumes.

Rate and Duration of Treatment has been varied with several soils and crops. Slight temporary toxicity without economic loss has been observed with corn where a 30-pound application was made inadvertantly for the second year. Lawn grass was slightly off color for 10 days following an application of 40 pounds an acre of boric acid. Yields of alfalfa have increased

with increasing rates of borax application up to 60 pounds an acre. It appears that 30 pounds an acre of borax can be safely used for most purposes. This 30 to 60 pounds has given commercial but not complete control of beet canker. Placement at the side of the row gave more complete control. A 30-pound treatment appears to be effective for 2 or 3 years. Most prompt results in experimental tests have followed where application was by sprinkling in aqueous solution. The borax may be broadcast with a cyclone type of grass seed hand sower. It has been used successfully by mixing with gypsum or superphosphate. Early application is important.

Boron in Soils and Crops: Some data as to boron in soils and plants appears in an earlier report (Powers, 1939). We are now using the quinalizarine method of Berger and Truog (1934) for nearly available boron.

Old soils, leachy soils, peaty soils or those derived from igneous rocks seem most apt to be deficient in boron. Soil reaction or liming, soil moisture content, colloidality and organic matter contents, and perhaps also temperature may affect boron availability. So boric acid may best be used for experimental tests on basic soils. Two pounds of boric acid will supply approximately as much boron as three pounds of borax.

The boron content of plant material tested has ranged from 7 to 50 parts per million and has been markedly lower in plants needing boron than in normal plants or those grown on boron treated soils.

There are now some 50,000 acres of alfalfa in Willamette Valley that will yield one-half ton to one ton more an acre from the borax treatment which costs about $1.00 an acre for a 30-pound application. Loss due to beet canker has been 8 to 10 percent and with celery up to 50 percent.

Twenty tons of borax were used for fertilizer in Oregon in 1939 and over 100 tons in 1940.

A minor amount of boron is a major factor in plant nutrition over wide areas of the Pacific Northwest and nutrition is a factor in natioal security.

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Economic and Social Zonation in Spokane

By WILLIS B. MERRIAM
Asst. Prof. Geography Oregon College of Education, Monmouth, Oregon

In recent years the city of Spokane, Washington has experienced a considerable boom in building. New homes and new industrial establishments following one another in constant succession as well as numerous rejuvenations of older industrial and business structures are the more noticeable evidences of this trend. This building and rebuilding not only indicates Spokane's mounting importance as a distributing center for the Inland Empire but also directs attention toward the environmental and economic factors that tend to establish the functional divisions of the city as it has developed a distinctive urban pattern.

Historic-Geographic Relationship

At the present site of the city the Spokane river tumbles more than 100 feet in a series of falls over basalt ledges. The aboriginal Spokane Indians for generations utilized the banks of the river near the main falls for their camping grounds, the shallow bed and low gradient of the stream above the falls providing a natural crossing place. This factor, coupled with a temporary pooling of fish below the falls, water supply, shade and wood, gave the site a regional focality that was noticeable even during Indian times.

Although white men became interested in fur trading in the Spokane country as early as 1810, it wasn't until more than 60 years later that actual settlement was effected on the river bank adjacent to the falls. Scattered traders and prospectors passed through from time to time but their headquarters were either Colville or Walla Walla.

Pioneer extractive economy did not demand power, hence the advantages of the site of Spokane as a trading and industrial center were not marked until the building of the northern transcontinental railroad in 1881 caused a shift in the main line of traffic from the Oregon Trail to the Spokane valley. This change caused the decline of Walla Walla as the chief distributing center of eastern Washington Territory and Spokane arose to perform that function.

Spokane owes its actual beginning to industry rather than commerce. Needs of the Coeur d'Alene mining camps for building materials and supplies encouraged the establishment of a saw mill and a flour mill at the falls in 1871 and 1873, the latter year marking the official beginning of the city.

Environmental factors account for Spokane's dominance as an industro-commercial city, and are five in number: (1) The city is located at a point where transportation lines converge because of topographic controls, offering favorable access by road or railroad, north, south, east, and west, but especially for east-west traffic across the Northern Rockies, (2) Spokane possesses large and productive surrounding areas, including the agricultural sections of the Palouse, Big Bend, Spokane valley, and the valleys of the Northeastern Highlands of Washington and the Rocky Mountain front of Idaho and Western Montana, (3) proximity to the rich Coeur d'Alene mining district, responsible for many of the early fortunes of the city, (4) accessible stands of commercial timber, and finally (5) abundant, easily developed hydroelectric power.

Population growth was slow from Spokane's inception in 1871 to the coming of the railroad in 1881. Census figures show "Spokane Falls" to be a village of 350 in 1880. The following year the estimate was 1000 and by 1887 over 7000 were estimated to be in the city. The census of 1890 gives Spokane a population of 19,992, or a 5,592 percent increase over the previous decade, due largely to the railroads and the development of the Coeur d'Alene mines. By the turn of the century 36,848 people were recorded, indicating a con-

tinued and substantial growth. In 1910 another important period of increase was experienced, netting the city a population of 104,402 due largely to a more intensive filling up of the agricultural lands in the Inland Empire. At this point Spokane rested for nearly two decades. No new resources were developed and few changes took place in agriculture. The 1920 census shows only 104,437. In 1930, 115,514 were recorded, due in part to a renewal of growth and part to the annexation of Hillyard, a railroad shop town in the northwest suburbs. The 1940 census indicates a growth of only 7,000 over 1930. Although this growth rate disappointed the Spokane Chamber of Commerce and several other agencies that predicted a city of 135,000 or 140,000, it is in keeping with the growth of the past 20 years and represents a larger percentage of growth than most cities experienced in the last decade.

Nearly every city as it grows to dominance expands, absorbs, and partially digests other small rival agglomerations. At least five such local residential or industrial districts, once completely independent of the city, may be detected in Spokane's urban makeup. These intra-urban centers include the East Sprague district (once East Spokane); Union Park, south of Sprague Avenue in the lowlands; Peaceful Valley, in the broadened flood plain of the river west of the city center; Lidgerwood, shown as a separate town on the Spokane Quadrangle, U. S. G. S., published in 1911, and Hillyard, the most recent unit to be annexed.

Environmental Factors Conditioning Spokane's Functional Areas.

The growth of Spokane to its present limits early resulted in its overflowing the valley plain both north and sou'h of the river. The gravel terraces back from the river that make up most of Spokane's north side uplands, offered no obstacles to the development of a rectangular street pattern. In the lowlands, however, there are local exceptions. Immediately north of the river in the central part of the city lies an outcrop of basaltic scabland, which has been enough of a hindrance so that only main through streets have been cut through it. North of these scablands, the valley plain permits the resumption of the regular street pattern.

Spokane's south hill districts lie largely on a basalt rimrock plateau. Scablands outcrop here, particularly in the Cliff Park, Manito Park, and Cannon Hill sections, also cause a deviation from rectangular streets, resulting in winding streets or through streets only where breaks occur in the wall of lava.

The railroad pattern, likewise, shows the influence of topographic controls to a marked degree. Three main lines pass through the city. Entrance from the east is attained by a fairly level and direct approach along the valley plain of the river, but exit westward offers many complications. The canyons of Latah Creek and the Spokane river provide distinct natural barriers The Northern Pacific secured the best right-of-way through the ci'y, crossing the barrier by descending into the canyon of Latah Creek on the east side by means of a terrace cut in a glacial gravel bank, and then heading up Marshall Creek to the southwest. The Great Northern has to cross the Spokane River three times to reach the city center. Extensive cuts were necessary through the scablands above the falls and the largest of the river islands has been used for the site of the depot and freight warehouses. This line leaves the city by a bridge and follows the valley plain to the margin of the Columbia basin. The Chicago Milwaukee and St. Paul encountered the greatest difficulties of all. In spite of much basalt digging from the east the line has to enter the city on elevated tracks, leaving by a bridge over Monroe Street, a long high river bank fill, and a high bridge over Latah canyon.

The bridge pattern of Spokane also reflects topographic controls. Above the falls the shallow bed of the river, the numerous basalt islands and resulting narrow channels, encourage bridge construction, but the canyon be-

low the falls, with one exception, has prevented the projection of streets across its course. This exception is made possible by the construction of a high level bridge across the canyon at its narrowest point immediately below the falls—the Monroe Street bridge.

The location of the Municipal Airport represents an interesting series of geopraphic adjustments. The gravelly soil of the river terrace provides a firm field and good drainage. The long axis parallels the direction of the prevailing winds and the proximity of the foothills on the north protects the field from local cross winds. The stony and gravelly character of the soil has discouraged its use for agriculture and consequently low land values enabled the city to secure an air field site within four miles of the city center. However, Felts Field, while large enough to accommodate the commercial traffic of today, it not large enough for the super air liners of the near future, and a new commercial and military site has been developed a few miles west of the city.

Land reserved for park areas by the city is found in nearly all of the topographic types, but the districts which lend themselves best to park development are the river terraces and the sections of basalt outcroppings.

Spokane's leading wholesale district owes its position to the location of the main rail transportation lines. Along these lines wholesale establishments have developed, replacing earlier business uses, in many instances, to secure railroad connections. A second wholesale district in which physiography has acted as a locational factor is found in the aforementioned scabland area north of the river. The irregularity of surface here prevents the extensive street pattern development necessary for retail commercial or residential use. Many railroad spurs penetrate this district, within which is the site recently levelled for a mail order warehouse. This section is coming into use largely as the basalt knobs are removed. Several rock hills have been removed already and ultimately all such outcrops north of the river will be eliminated.

Retail commerical districts have developed chiefly on the river valley plain on the south side of the river, with arms projecting along the traffic ways leading to outlying parts of the city. The origin of the central retail district is traceable to early settlement by the falls. Industrial plants that may have started here, with few exceptions, have been forced to migrate to cheaper land areas, leaving the retail district in complete possession.

Expansion of the downtown retail commercial district is blocked on four sides by effective natural barriers in the form of basalt uplands and the river's bends. Overflowing these barriers retail commercial arms have developed along most of the principal highway arterials leading to the extremities of the city, such as North Monroe, Northwest Boulevard, Sprague Avenue, Division Street, and others, amounting in most cases to rather complete centers of decentralization.

The restricted area suitable for commercial use has meant that the tendency of the main retail trade center to migrate, has been minimized more than in most cities. Spokane's center of highest rent values has not moved more than a block or two in 40 years. There are obsolete blocks in which second-hand stores, pawn shops, pool halls, rescue missions, employment offices and cheap hotels and sleeping rooms for transcients are to be found on Trent and Main avenues, but the fact remains that the older vs. the newer sections of the city can scarcely be distinguished. Spokane's commercial center has evolved not so much through areal expansion as by replacement.

Manufacturing districts are found on the valley plain east of the commercial district, extending outside of the city limits. They have developed along the main lines of the railroads entering the city, not only because of access but because of an abundance of level land, too gravelly for agriculture, thus as-

suring low land values and sparse settlement. There is a great deal of this type of land in east Spokane, hence the conclusion that there is ample room for manufactural extension and intensification in east side Spokane.

Coupled with favorable land values for manufactural site location is the factor of winds. Lumber mills, reworking mills, packing houses, gas plants and other industries typical of east Spokane are likely to be either noisy or odoriferous, hence the tendency for them, with popular approval, to lie on the leeward side of the city. One exception to this pattern is the location of the old Phoenix Mill (Long Lake Lumber Company) near the falls at the south end of the Post Street bridge, which holds its place because of an early start and the inertia of industry. The Centennial flour mill, just across the river on Howard Street is also a remnant of early industrial development within the commercial and wholesale area, permitted to remain because, like the lumber mill, it is situated on a spot that is not attractive for competing forms of economic use.

A study of residential districts also shows some interesting economic and social relaticnships growing largely from the physical environment. The first class residential districts are confined almost entirely to the so-called South Hill, limited on the north by a crest of basalt rimrock. Here are to be found a variety of natural beauty features for landscaping. Locations overlooking the city are dominant and prominent. Palatial houses here are newer. These districts are largely the result of modern transportation. In earlier days they were prohibitively inaccessible. Today most of the show spot residences of Spokane are to be found in the Cannon Hill, Manito, Rockwood, Comstock Park, Cliff Park, and other first class residential districts of the South Hill.

Second class districts include most of the rest of residential Spokane. These districts are second class for at least two reasons. Usually they provide homes for middle class working people, or else obsolescence has cut the property values on first class units of a former day. Brown's Addition, west of the commercial district in the river plain was at one time the best residential section of the city, but at present most of its mansions have been converted into apartments and boarding houses, and it is definitely a second class district today. Obsolescence, however, is only part of the story here. The Northern Pacific railroad runs along the southern margin. Along the railroad and the highway lines the wholesale district has gradually extended, and along the eastern margin the commerical district has impinged.

Surrounding the commercial and wholesale districts in the eastern part of the city, frequently representing the earliest and oldest houses, left behind in the drift of residential districts outward from the city center, lie the third class distrcts. These areas are now occupied by that part of the city's population whose economic status forces their residence in these less favored zones. Here are found most of the colored folk and other less easily assimilated elements in Spokane's population. This type of residential district is also co-extensive with the industrial district, because the less skilled laborers tend to reside near the place of their employment.

Spokane's Future Expansion Pattern

Two or three decades hence, what will Spokane's structure pattern be? Although Spokane, like most cities today, probably will not increase greatly in population, it can be safely assumed that Columbia Basin and Grand Coluee power development will prove sufficient incentive for a continued though modest growth.

It is reasonable to assume that commercial and business centers will not expand much as in arreally. Restricted commercial and business areas will undoubtedly mean a further pressure of buildings upward, and more and more replacement of the obsolete rather than abandonment and migration. This

transition is already taking place in down-town Spokane to a marked degree.

There is no reason why the south hill residential district will not expand between Latah creek canyon on the west and the granite knolls southeast of the city, up to and including the Moran district. Westward the canyons of the river and Latah creek will check expansion in this direction in spite of a residential drift between Spokane proper and Geiger Field. Northward the city can and doubtless will expand up to the foot of Five Mile bluffs and will ultimately include the Country Homes district and the Whitworth college campus. Eastward, fine suburban homes, and industrial and commercial sites may continue an eastward drift that is likely to engulf several of the satellite towns in the Spokane valley. Street patterns, telephone exchanges, and arms of industry and commerce along the railroads and main highways are endeniable forerunners of this future extension.

ABSTRACTS

Some Parasites of Fresh Water Fish of the Spokane Area

By PAUL V. GUSTAFSON
Whitworth College

Initial investigations show a high incidence and considerable variety of helminth parasites endemic in certain game and non-game fishes.

Rainbow trout and Eastern brook trout, (Griffith Springs,) had 100 per cent infection of Cucullanus sp., and occasionally other parasites. Smallmouth black bass from Williams Lake had heavy infections of a Tetraphyllidean cestode. Likewise squawfish and other Cyprinids from various sources showed a consistent parasitic fauna.

Other species have been found almost entirely free of helminth parasites in the regious investigated. Silver trout (Onchorhyncus nerka) from Deer Lake, Loon Lake, and Sullivan Lake, showed almost total absence of infection. Some minnows from Deadman Creek were also free from such parasites.

Individual hosts and parasites were discussed in detail.

FLUORESCENT LIGHTING

By J. HUGO JOHNSON
Dep't of Electrical Engineering, University of Idaho

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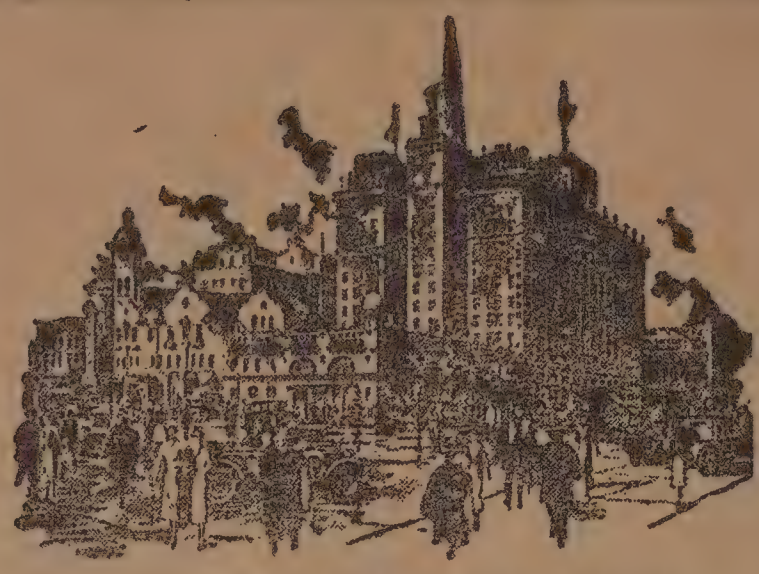

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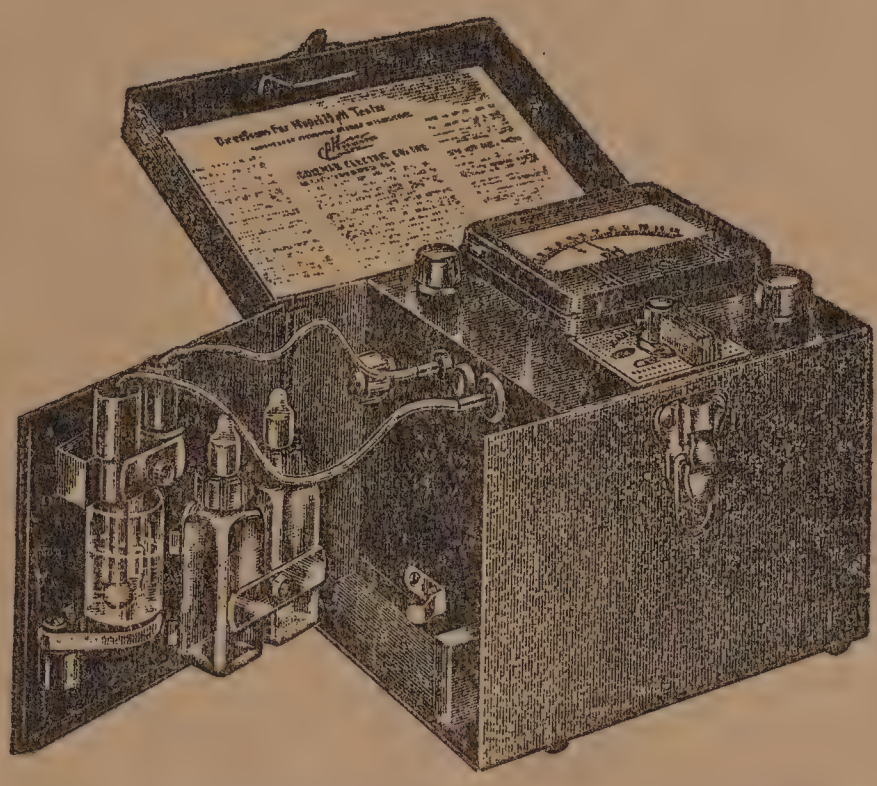

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The twenty-sixth annual meeting of the Pacific division of the A. A. A. S. will meet in Salt Lake City, June 15-20, 1942, with the headquarters for the meetings at the University of Utah.

On Tuesday morning, June 16th, there will be a symposium on "The Great Basin, with Emphasis on Glacial and Post-Glacial Times." Speakers will be Elliot Hubbs and R. R. Miller on "The Zoological Evidence" and Ernst Antevs on "Climatic Changes and Pre-White Man." Professor D. R. Hoagland, President of the Pacific Division of the A. A. A. S. will speak Tuesday evening on "Progress Investigations of the Nutrition of Plants." Other general lectures will be given Tuesday afternoon and Wednesday and Thursday evenings.

Section meetings will be held and programs presented by the following:

American Association of Economic Entamologists.
American Association of Physics Teachers
American Chemical Society.
American Geophysical Union, Section of Hydrology.
American Meteorological Society.
American Phytopathological Society.
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American Society of Ichthyologists and Herpetologists.
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Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes 1 to XV, 1927 to 1941, each $1.25.
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Editor, Otis W. Freeman, Cheney, Washington

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According to Secretary H. F. Raup, only 69 members out of 240 to whom notice of dues for membership in the Northwest Scientific Association was sent, have paid their $1.00 for 1942. He would much appreciate having the members promptly send him their $1.00 dues to Cheney, Washington.

The sudden death of Prof. J. H. Ramskill, of the Department of Forestry, University of Montana, and a former president of the Northwest Scientific Association, came as a shock to his many friends and fellow scientists. An obituary will appear in the next issue of Northwest Science.

Symposium on Management of Impounded Water in the Pacific Northwest

Management of Storage Lakes of the Four Northwest States

Thomas Large

In the Northwest states west of the middle of Montana there are some 87 lakes or reservoirs which are now utilized for storage water. There are also in this area 78 sites which have been surveyed and found suitable for additional reservoirs. Such lakes are used for storage of water for mining, for irrigation and farmu se, for hydroelectric power and in some instances, for improvement of the site for recreational or sport purposes. In the greater number of these reservoirs, it is common belief, that such water storage, because of the "draw-down" at unseasonable intervals or because of excessive "draw-down" is highly destructive of the growth along shores which furnish food and favorable cover or protection for wild water fowl and for young fish,

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insect and other animal foods needed for the promotion of growth of game fish.

In so far as is known, this meeting is the first ever called for airing of this subject in its biological aspects. In his preconvention circular to members of the American Limnological Society, Dr. Paul S. Welch, Secretary of that organization, suggested that if sufficient titles were received from members wishing to appear on the program held in connection with the A.A.A.S. at Dallas, Texas, a special time would be set aside to discuss the subject of storage lakes, so important to the Southwest. When their program appeared, however, only two papers were listed. (Both of these were by men who would have appeared on the program in Spokane had not the opportunity to appear on the national program taken them to Dallas.)

Frankly speaking, no one knows much about this subject. Yet every one to whom Dr. Hatch has written in preparation for the program for this symposium has agreed that it is a live subject of high importance. This gives us an ideal set-up for starting a volunteer research program on a cooperative basis. One does not have to be a trained Limnologist to furnish significant information of importance in such a cooperative venture.

Acre for acre water can produce, some believe, as much as the land. As with fertile and infertile land there are fertile and infertile lakes. Limnologists suggest the names for three grades of lakes on basis of relative productivity. (Oligotropic, mesotropic and eutropic indicate grades of poor, medium and excellent.) There is possibility of modifying the conditions which are responsible for the unsatisfactory states just as there is possibility of building up an unsatisfactory condition of farm fertility. To make a farm raise more corn is not so simple as merely planting more corn. Likewise the way to have more fish in our lakes is not so simple as merely going to the fish hatchery and getting a can of fish and dumping it into the lake. In the state of Michigan an informed and progressive Institute for Fisheries Research has worked out and offered to the public many plans by which local groups may at little expense do many things to restore the original productivity to lakes which have not been benefitted by over energetic Homo.*

For the storage lakes, however, formulas have not been worked out. Hence meetings such as this for pooling our knowledge. No idea prevails that such lakes should be returned to their original condition by removal of dams already constructed. There may be situations where construction of two low dams in place of one, thus spreading the stored water over a greater area to secure lower heads, may preserve the original natural fertility of the lake and, the original crop of fish and waterfowl be even improved. But in general it should be understood that the Limnologists have a long way to go in improving conditions for high fertility even in normal lakes and in our present state of lack of information much research must be done before we may presume to do more than very cautiously advise some improvements which seem to deserve experiment. For research of this type at this time no federal aid need be expected nor need we expect that already established governmental agencies go far out of their way to put over programs not already approved by congress.

With this situation understood it may be seen as a wide open field for private research. A field to be exploited by the ambitious seeker for material for theses for budding Masters and Doctors. Albeit it may not be an unpleasant field and it may lead literally through pleasant pastures and by still waters.

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* "Improvement of Lakes for Fishing", Institute for Fisheries Research, Univ. of Mich., Ann Arbor, Mich., 1938.

Ecologic Relations of Vegetation in Impounded Waters

R. F. Daubenmire

University of Idaho

The recreational value of a lake is greatly influenced by the relative abundance of fish and other forms of wildlife which inhabit the area. The potentialities of any lake with respect to wildlife production in turn depends largely upon the quantity and quality of the vegetation which it supports.

A major problem in the hydrobiologic development of lakes used for irrigation is presented by the great annual fluctuation in the water level due to the periodic withdrawal of water. This character of impounded waters imposes severe limitations upon those plants which grow attached to the bottom, and they are the types which are of most importance for waterfowl and muskrats. Game fish are less directly dependent upon vascular plants as sources of food, at least in this part of North America, so that the maintenance of a high level of fish production in the lake behind Grand Coulee Dam should not present as difficult a problem as with waterfowl and mammals.

The importance of the larger water plants in providing food for birds and mammals, and in retarding erosion of the periodically exposed aprons, warrants the expenditure of funds on research aimed at getting an abundance of the most desirable species established in the lake. As one phase of the hydrobiologic development of the Grand Coulee area it is recommended that each species known to have high wildlife value be tried in experimental plots to find which are best adapted to the environmental conditions offered by this particular lake.

The Influence of the Grand Coulee Development on Birds and Mammals

Leonard Wing

Washington State College

This paper will be limited to a discussion of bird and mammal wildlife. It is obvious that the Grand Coulee impoundment itself will affect fish most of all forms of wildlife. The influence of the land development which will follow the availability of water, however, will be most apparent on birds and mammals.

For the sake of brevity and organization, this discussion will be divided into three man parts; with emphasis upon the third part. This division is: (a) the probable land changes and their influences, (b) administrative problems and (c) procedures which we can undertake in order to be ready when the changes are effected.

Let us now turn to the probable changes and see if we can work out some of their influences on the future of wildlife in the developmental area. At the present time the area is marked by a scarcity of cover for farm game. The bringing of water to large areas of dryland, it is obvious, will automatically provide conditions suitable for more cover. But what kind of cover will we get? A look at the cover possibilities from the standpoint of wildlife management brings three possibilities to light. Will the cover be desirable, will it be merely passable, or will it be definitely objectionable? This is a point of considerable importance and I will touch upon it again.

It is obvious that the vegetation changes are bound to be felt by wildlife; it is also obvious that the effects of human presence are going to be felt as well. Pheasants, hungarian partridges, and valley quail, for example, will undoubtedly be benefitted at the expense of sage grouse. (Inasmuch as there are few sage grouse now existing in this region, I might better say, at the expense of potential sage grouse.)

The cottontail rabbit will no doubt expand at the expense of the jack rabbit. We can sum up the changes that will be felt by game birds and mammals as simply this: open range game will suffer, farm game will benefit. This very fact gives us a clue to some possible undertakings, and I will soon mention them.

It is perfectly obvious that waterfowl will be benefitted to some extent by the mere presence of additional water—but without some management operations, we shall be indeed disappointed. Mere water is not enough for waterfowl. Too many people, especially the sporting brethren, are too prone to believe that water is everything for waterfowl.

On the contrary, many bodies of water—in fact, far too many bodies of water—are but biological barrens, mere wildlife voids. Unless effort, much effort, is made I fear that the Grand Coulee impoundment may become one of the world's great biological deserts, at least so far as waterfowl are concerned.

If we look at the cultural aspects of the Grand Coulee development and their influence on wildlife, we can but foresee a break-up of the land holdings into smaller ones and the attendent multiplicity of complications which this fact involves. The land will change from range and wheat land to gardens, orchards, and towns. This automatically means not only direct influence upon wildlife habitat, but also increased administrative problems. It means more people in the area; consequently, it means more pressure on wildlife. There will be more poaching and more need for law enforcement. There will be less area for game, but it will be of a different type and often of better quality. It is a question, however, if the increased productive capacity of the area, from the standpoint of farm game and fur-bearers, will offset the increased hunting and trapping pressure which, naturally, is bound to be great.

The fact that there will be small holdings indicates to us that some form of cooperative effort among the land owners is essential if the game crop is to be substantial. The pooling of acreage for game purposes has proved to be a solution to many of the problems attendant upon small holdings, and game pools have succeeded well in some parts of the country. They require considerable technical assistance, however, if they are to function successfully. The source of such technical help in other parts of the country is the state game departments and public colleges and universities. The source of technical help for the Grand Coulee project is the State Game Department and the State College. I may say frankly and with candor that neither agency is yet prepared to supply this technical assistance, but I sincerely hope and expect that both will be ready when the time comes.

The possible undertakings which we can start now, in order to be ready when the time comes, can be classed primarily as research and demonstration, and I should like to speak for a moment about these.

The most elementary undertaking in wildlife management is a wildlife survey and we need such a survey of the Grand Coulee development area. We need not merely a game survey, but a complete survey of all the wildlife and its habitat as it **now** exists before any changes have taken place. This information will be invaluable later when we are dealing with changes after they have occurred. This wildlife survey should be under way already, but it is still not too late to start.

In order to improve the environment for wildlife, it is going to be necessary to establish food and cover plants, especially in waste areas, along roadsides, along canal banks, and in similar areas not needed for agriculture. Right now we should start an experimental nursery for the purpose of finding out what kind of trees and shrubs are best for wildlife food and cover in the area and at the same time which will grow rapidly, which will be hardy, which will require little water, and which will be easy to handle. We need to know a lot more about propagation of waterfowl food plants and the experimental

nursery should be so situated as to include these. The nursery should expand into a permanent wildlife food and cover plant nursery analogous to the forest tree nursery at Pullman.

Future food for wildlife in the area will undoubtedly be low in proportion to the amount of cover because of dryness. We should set up experiments to determine the use of food patches, to determine the best varieties of food-patch plants best adapted for the conditions of the developmental area, and to work out methods of growing food-patch plants.

We need a waterfowl study very badly in Eastern Washington and the development of Grand Coulee makes it even more imperative that we conduct such a study. I now have a student making a beginning on a waterfowl management research project, small though it may be. The first job to tackle in a waterfowl research study so far as Grand Coulee is concerned, is an investigation of factors bearing upon the productivity of the area in order to obtain data for the making of a management plan. Such information will be of tremendous value when water is at last loose on the land. There are many ponds and channels which no doubt could be kept in marsh for waterfowl with but little effort.

The effect of fluctuating water levels in the Grand Coulee impoundment is bound to be enormous from the standpoint of waterfowl. Few aquatic plants are able to withstand long and pronounced exposure. The production of waterfowl foods by plants, therefore, will undoubtedly be low. On the other hand, the "draw-down" may make it possible to plant quick-maturing grains or other plants, especially greens, in order to provide waterfowl with food after the surface of the water rises again.

If the irrigation ditches themselves as well as the Grand Coulee impoundment do not produce as many more waterfowl as the increased kill by hunters, the area becomes definitely unfavorable to waterfowl by virtue of the fact that it has increased the kill without proportionate increase in the production. It is logical to assume, therefore, that refuges will be in order. It may be that waterfowl hunting along irrigation canals and around Grand Coulee should be prohibited entirely because the kill may be far and above the production. In that case, it will prove easier to close the canals and Grand Coulee to waterfowl hunting **before** the influx of settlement.

There are many other problems involving game birds and game mammals. We know little about the ecology and life history of game birds and mammals in the region. We know little about the life history and habits of fur-bearers, yet they may become an important economic resource in this area. We do have some information on the hungarian partridge and pheasant in the Palouse region because of the fine work of the State Game Department biologists and the students at the State College. It is likely that much of this information will be applicable to the Grand Coulee area.

It seems to me that a cooperative arrangement shoud be entered into by the three agencies so intimately connected with the Grand Coulee development—namely, the State Game Department, Reclamation Service, and State College of Washington for a program of research and demonstration in advance of the actual settlement of the area.

I would list the subjects of immediate investigation under four headings: (1) a wildlife survey of the area as it now stands, (2) the study of the life history, ecology, and management of certain species:

a. waterfowl
b. fur-bearers
c. valley quail
d. sharp-tailed grouse
f. hungarian partridge
g. pheasants
h. sage grouse
i. rabbit
j. antelope

(3) experiments in the production of food and cover nursery stock and in the use of food patches, and (4) studies on the use of cooperative game pools.

BOTANY-ZOOLOGY PAPERS

Some Observations On the Flora of Shoshone County, Idaho

C. B. Wilson
High School, Pullman, Washington

As a contribution to the Northwest Scientific Association's project of completing an intensive study of the flora of the Pacific Northwest, a series of collecting trips were made into Shoshone County, Idaho, in the summer of 1941. Relatively little systematic collecting has previously been done in this area. The American botanist, John Leiberg, collected in the County around 1890. In recent years Dr. Carl Schaarsmith and Dr. Marion Ownbey, taxonomists at Washington State College, have made short trips into the region and W. R. Moore, a student at the college, has done some collecting while acting as a Forest Service "lookout" in the county.

The present study was undertaken in connection with the 1941 summer session of the State College, under the direction of Dr. Ownbey. Funds for financing the work were furnished jointly by the Northwest Scientific Association and the Botany Department of Washington State College.

Four trips, of three or four days each were made into the county, between July 9 and August 5. The first trip extended across the county from Clarkia in the southwest corner, along the Forest Service road across the central part of the county, through Avery, to Quarles Peak lookout station, on the Montana state line, northeast of Avery. The remaining trips were devoted to further collecting along the road from Clarkia to Avery with side trips to Jug Mountain and to Bearskull Ranger Station, also for a few miles along the new logging road running east from Gold Center, a few miles from Clarkia.

The variety of habitats included in the survey is considerable. The elevation varies from 2844 feet at Clarkia to 6400 feet at Quarles Peak. The southwest corner of the county is an old, cut-over area, now partly in farm land. The central part of the county consists of a series of high ridges and isolated peaks, up to 6000 feet in elevation, and with deep valleys and ravines drained by tributaries of the Clearwater and St. Joe rivers. The ridges and peaks of this section are quite generally bare of timber except on some of the northerly slopes. The valleys are mostly timbered. Not much lumbering appears to have been done in the region. The route followed crosses the Little North Fork of the Clearwater River at Clearwater Camp about fifteen miles south of Avery, and the road to Quarles Peak runs along the north fork of the St. Joe river for fifteen or twenty miles. Quarles Peak is on the main watershed of the Bitter Root Mountains. A number of small lakes and numerous mountain meadow; marsh and bog areas occur in the central region. Sheep are being run on parts of the area.

Four hundred and fifteen separate collections were made, ranging from one to ten or more specimens each. The identifications are not yet complete but approximately 240 species were collected. No attempt has been made to determine the number of new county records but it is estimated that perhaps half of the collections are new. At least one new record for the state of Idaho is included, Parnassia intermedia, in the Saxifrage family.

Some of the more conspicuous features of the flora, outside of the conifers, include: the Pine Lily, or Bear Grass, Xerophyllum tenax; Pearly Everlasting, Anaphalis Margaritacea, var. occidentale, which occurs in abundance nearly everywhere; species of Arnica, mostly Arnica longifolia; the Mountain Daisy, Erigeron salsuginosus; Green Hellebore, Veratrum Eschscholtzii; the dainty, blue flowered, Polemonium columbianum; and the wild Heliotrope, Valeriana sitchensis. Several species of hawkweeds and lupines abound. About Quarles Peak the common Larkspur, Delphinium Nelsoni, and the wild Columbine, Aquilegia formosa, are common.

In the bogs, marshes, ravines and in the timber numerous representatives of the heather and orchid families occur. The heaths include such interesting forms as the Bog Heather, Kalmia microphylla; the parasitic Pine Drops, Pterospera andromedea; Kinnikinnick and Pipsissewa, or Prince's Pine; the Wild Beet, Pyrola bracteata; a bushy, thicket-forming species, Ledum glandulosum; common huckleberry, Vaccinium membranaceum, and the Grouseberry, Vaccinium scorparium. On some of the higher ridges are extensive patches of the beautiful Pink Heather, Phylodice empetriformis. The orchids include such species as the dainty white, Hooded Ladies' Tresses, Spiranthes Romanzoffiana, which grows among the peat moss of bogs; species of Habeneria, including the Tall White Bog Orchis and the Slender Bog Orchis; and in the woods, mostly under Hemlock trees, occurs the parasitic Spotted Coral Root, Corallorrhiza maculata.

In a marshy area on the side of Quarles Peak and in similar areas near Jug Mountain and along "Trail 32W" in the same locality, three umbellifers grew in abundance. They were the Water Hemlock, Cicuta vagans; Lovage, or Ligusticum Canbyi, and a species not yet identified. Another spot of special interest is a meadow below Freezeout Saddle in the vicinity of Freezout Mountain, which is said to take its name from a tragic incident of the Chief Joseph Indian war. The meadow itself is nearly level and surrounded on three sides by high rocky ridges. In one part of it there was an extensive patch of the brilliantly yellow flowered St. Johnswort, Hypericum Scouleri. Another part is boggy. with a small stream meandering through it, along which there were many clumps of the large, blue-flowered gentian, Gentiana calycosa. At another place along a dry, rocky water course was a thick growth of a deeply blue-flowered speedwell, Veronica Cusickii, extending far up the side of the steep ridge from the edge of the basin. At another place there is an extensive thicket of a low growing, thick-leaved willow, probably Salix sitchensis. On the southerly slopes of the ridge about Freezout there were also extensive patches of the low-growing, mat-forming legume, Lupinus aridus, also a seemingly rare species of Lomatium, Lomatium Sandbergii.

Other plants of interest in the collection include the crimson Monkey Flower, Mimulus Lewisii, which occurs in large clumps in or near the water of the mountain streams and about cold springs: in the same kinds of places, but less commonly, occurs a larger cousin of the Dutchman's Breeches, Carydalis Cusickii; on a high rocky ridge at Quarles Peak was the large, pink-flowered legume, Hedysarum occidentale; in a restricted area along the St. Joe, north of Avery, Penstemon Lyallii occurs; along some of the lower canyon walls is seen the maple-leaved Mallow, or wild holyhock, Sphaeralcea rivularis; along the streams also may be seen the cone-shaped heads of the Nigerhead, Rudbeckia occidentalis; on nearly bare rocks or dry sandy knolls occur the mat forming sandwort, arenaria formosa and Phlox rigida. In a marsh at Clearwater Camp and also at Round Top Ranger Station a delicate little, prostrate St. Johnswort, Hypericum anagalloides, grows on the moss; in damp, cool places may be seen the striking looking pink-flowered Lousewort, Pedicularis groenlandica. Cirsium edule, a real thistle, growing seven feet high, may be seen along the river road north of Avery.

Plants making up much of the brush and deciduous thickets are the Sitka Alder, the Mountain Ash, Fool's Huckleberry, Ocean Spray, two Spireas, the Douglas Maple, Service Berry, Aspen, Syringa, Snowberry, Black-berried Elder, and the Black-berried and the Red-berried Twin-berry.

Some of the more important families represented in this collection are the composites with over 30 species, the Figwort family with over 20 species, the Heath family with 15, and the mustard, buttercup, Rose, Dock, Lily, and Saxifrage families with 10 to 15 species each. The Orchid, Pink, Legume, Umbel and Evening Primrose families are

also well represented. In all 38 different families are included.

This summer's work must be considered as only the beginning of a systematic study of the flora of Shoshone County. Collections should be made earlier in the season, and there are large areas in the southeast, north, and northwest parts of the county which have not yet been visited.

It is expected that the identifications will be completed in the near future after which the material collected will be on file in the herbarium of the Washington State College, at Pullman.

ABSTRACTS

Isolation of Fungi Associated with Brown Cubical Heartrots of Western Redcedar

Robert F. Patten
School of Forestry, University of Idaho

An investigation of the brown cubical heartrots of western redcedar in northern Idaho has been initiated in the Forest Pathology Laboratory of the University of Idaho. Although their importance is generally recognized, very little is known about them, and it is the ultimate purpose of the project to formulate control measures for the rots. The immediate work is concerned with a study of the etiology and symptomatology of the two types of rots, the continuous trunk rot and the pocket trunk rot.

A large number and variety of fungi have been obtained in pure culture from many different rot specimens. Recent work on the initial stage of decay has resulted in three isolates, as yet unidentified, which may be suspected as possible primary agents of decay. It is interesting that their position of occurence in relation to the rot and to one another suggests the possibility that a synergic or metabiotic action may be involved. Experiments are also in progress to test their saprogenicity, by making artificial inoculations with these isolates, both on western redcedar heartwood test blocks, and in sound living trees.

Some New Uses for the 2 x 2 Projector

Philip H. Pope
Whitman College

Either sections or whole mounts of rather large material, prepared by the usual histological methods and fixed to 2 x 2″ slides can be used to great advantage in the projector.

Such materials as whole chick embryos, feathers, the sclerotic bones from a duck's eye, whole insects, cross sections of plant stems or entire small leaves may be used.

Histological details fail to show but in cross sections of an embryonic dogfish the relationship of the principal organs like nerve tube, notochord, gills, myotomes, and intestine can be seen very plainly.

A special slide carrier that I made to carry microscope slides has proved practical but the shape of the slides makes them harder to handle than the 2 x 2″ size. I have not yet tried making a water cell for small aquatic forms but plan to do so very soon.

The low cost, brightness and ease of manipulation make the 2 x 2″ projector a very useful teaching aid, especially since it is so easy to make Kodachrome slides with a miniature camera and at least one supply house is making photomicrographic slides to order from stained histological material. I am continuing my experiments with large histological subjects in order to widen a field that looks very promising to me.

ABSTRACTS

Secondary Fungi Associated with White Pine Blister Rust Cankers

R. T. Bingham
University of Idaho School of Forestry

A fairly large number of species of secondary fungi are found associated with western white pine blister rust cankers. Two of these secondary fungi (Tympanis hypopodia Nyl. and a Dasyscypha species tentatively identified as D. calyciformis (Willd.) Rehm) are the most important from the standpoint of both frequency and distribution.

The secondary fungi exert some measure of biological control over the blister rust disease. This effect is one not before fully appreciated. Very little control is exerted where white pines are already infected by the blister rust, but the spread of blister rust is probably considerably reduced by the action of secondary fungi in reducing the aecial sporulation of the rust.

The Action of Some Compounds on Malt Diastase Activity

Albert E. Braun
University of Idaho

It was desired to ascertain the effect of some "minor elements" on the activity of malt diastase (amylase), especially in very dilute consentrations.

The starch preparation was purified by dialyzing in a colloidion bag against redistilled water. The same was done with the diastase preparation, to obtain it as free as possible of other ions. All water used in the experiments was redistilled.

The determination of the amount of starch in a solution was made with a photelometer. This is a colorimetric method and the coloration is formed by the addition of IKI to the solution. This method was first described by Palohimo and published in Biochemische Zeitschrift in 1932.

To compare the solutions on the same basis, they were calculated to the same ionic strength by use of the Lewis & Randall formula:

c molal concentration
z valence of theions

$$u=\frac{\Sigma\, c_i z_i^2}{2}$$

For example $MnCl_2$ for a one molal solution

$$u=\frac{1}{\text{conc.}}\frac{(2)^2 + 1 \times 2}{2} = 6/2 = 3$$

The compounds used were $Mn\,Cl_2$, $Zn\,Cl_2$, $FeCl_3$, H_3BO_3 and $CuCl_2$. With concentrations of .0003 ionic strength, $MnCl_2$ increased the rate of reaction the most and $ZnCl_2$ was next in order. $FeCl_3$, H_3BO_3 and $CuCl_2$ decreased the rate of reaction as compared to a solution which had no mineral compounds added, in the order given. With stronger solutions it was found that .3 ionic strength of $MnCl_2$ the maximum rate of reaction was obtained, and .0003 ionic strength of $ZnCl_2$ gave the maximum rate.

RECENT DEVELOPMENTS IN PINE SILVICULTURE

Thornton T. Munger and Philip A. Briegleb
Pacific Northwest Forest and Range Experiment Station

Within the last few years a revolution in ponderosa pine logging methods has taken place and is probably still taking place. Tractors have replaced horses, and trucks, traveling on cheap roads, are fast replacing railroad equipment hauling on expensive roads. The modern tractor requires no road in most pine country; it can ramble out a quarter mile, half mile, or even a mile and haul in a single tree, for not very much more per thousand feet than for a dozen trees. To lay down a network of truck roads sufficient for tractor skidding costs but a fraction as much as to build the railroad spurs necessary for a horse skidding job. With this lowering of skidding costs and of "fixed-per-acre-costs" there comes a flexibility in pine logging that has given the silviculturist a great opportunity, and he is taking advantage of it by radically modifying the method of cutting ponderosa pine stands for continuous production.

It is of this we wish to speak today, particularly as it applies to Oregon and Washington, the territory of the Pacific Northwest Forest Experiment Station.

In the horse days, before the modern tractor, arch, and truck invaded the woods, it was thought that the cut must be at least 75 or 80 percent of the stand to make the operation profitable. It was the prevailing practice then on the national forests, Indian reservations, and other public lands, practicing the best sustained yield forestry they knew, to mark for cutting 75 to 85 percent of the merchantable volume. This presupposed a cutting cycle of about 60 years. With such heavy cutting there wasn't much choice but to leave the obviously immature and thriftiest trees. Marking was a simple matter.

Some silviculturists argued even in those days that lighter cutting would be better forestry and wished that it were economically feasible. Meanwhile a knowledge of the silvics of ponderosa pine was accumulating from one source and another and pieced together it pointed toward the wisdom of lighter cutting. A permanent sample plot to test lighter cutting alongside of the conventional 80 percent cutting was established as early as 1913 and another series again in 1927. The accumulated evidence, gleaned from studies of Westveld, Meyer, Weidman, Keen, Munger, and the unpublished observations of many others, indicates several advantages to light cutting and therefore a shorter cutting cycle from the silvicultural viewpoint, which we will briefly review.

1. Under light cutting the fire hazard following logging is much less and the great expense of slash disposal can partly be saved.
2. The windfall hazard is less following light than heavy cutting.
3. A light cut means rapidly going over a working circle, perhaps in 30 years instead of 60 and thus removing from the whole stand the very most mature trees in double quick time, and so salvaging many trees that would not survive through a longer cutting cycle.
4. Likewise a light cut can remove from the whole working circle in relatively quick order the types of trees that are particularly susceptible to bark beetle attack, and thus forestall insect losses.
5. The light cut preserves "forest conditions" better than an 80 percent cut, a consideration from the point of view of soil erosion, excessive insolation, and aesthetics.
6. The light cutting, short-rotation practice installs a transportation system of permanent roads and puts the whole tract under management in quicker order than under heavy cutting, thus making possible better protection, more salvage, and intensive utilization of special products, over the whole working circle.

These silvicultural advantages of light cutting, obvious though they were, could not bring about a change to light

cutting, unless and until it was shown that lighter cutting was financially feasible. By 1935 the revolution in logging methods was well advanced and Brandstrom then began a series of economic studies of the cost of every step in logging by modern machine methods. His studies were much more than logging-cost studies. They analyzed the economic composition of the forest and of the individual tree to determine not only the cost of converting the tree into lumber but the value yields of every type of tree and log. Concurrently sawmill production studies were carried on under the direction of Lodewick at several plants to give the sales realization values of six log grades for every diameter class.

Brandstrom's work was by no means limited to showing the relative costs of light and heavy cutting. His great contribution was in showing from the long-term financial viewpoint the order of cutting that should be followed to attain maximum value increment with the minimum of logging cost and of carrying charges.

Out of these economic studies of Brandstrom and Lodewick, when combined with the growth studies of Meyer, the mortality studies of Keen, and the observations and experience of many others, has developed a system for cutting ponderosa pine forests, which we at the Experiment Station have named the maturity selection system.

Not very much has been written about this method, although in somewhat modified form it has already been applied to hundreds of thousands of acres in Oregon and Washington, and so we hope to introduce it to you today and explain very briefly its underlying philosophy.

The maturity system contemplates harvesting first the trees that are most mature, economically and biologically, from the entire working circle. How economic and biologic maturity are determined will be explained later. Under this system the forester thinks of the whole tract and not just the acre he is marking. Thus he prefers to leave standing some mediumly mature trees on this year's cutting so that he can get sooner to some very overmature trees in the back end of the tract. The exact percentage of cut is not important; it should vary according to the stand structure, fixed charges, etc. It might be anything from 25 to 65 percent; the important consideration is to go over the virgin acreage quickly, harvest the overmature trees quickly, put the whole forest in growing condition, establish transportation everywhere, and retire the capital in the nonproductive elements of the stand. This method is possible because of the great range and variety in the age, thrift, size, form, quality, and value of the trees in a virgin ponderosa pine stand. This is so obvious to anyone who works in these woods that enlargement on this point is unnecessary. It is not unusual in a tract to find that the stumpage value of individual trees ranges from plus $8 to minus $3 and the net growth rate from plus 4 percent to minus 3 percent.

Now let us consider what we mean by economic and biological maturity and how we determine them. We must grant that growing of timber **for use** is the principal objective of forestry and, therefore, unless there are other complicating objectives like recreation or watershed protection, the forester's job is to grow the crops that will pay the best dividends. This means harvesting first the trees whose net carrying charges per thousand feet of timber capital are the largest. The carrying charges are made up of four elements—and please note that two of these are biologic and two financial; here is where the biological or silvicultural considerations are blended with the financial or economic considerations. These four elements are:

1. The gross volume growth of the tree in percent.
2. The mortality probability in percent,
3. A carrying charge, usually assumed to be 3 percent, on the capital represented by each tree, on the very logical assumption that capital released by the cutting of a tree can be put into other

TABLE 1

Samples of Tree Classification and Evaluation from Pringle Falls Plot 37

Keen tree class	D.B.H.	Volume shipping tally	Grade of first two logs	Lumber sale value per M'	Logging * and milling cost per M'	Marginal * value per M'	Annual rates of -Gross growth	Annual rates of Mortality	Annual rates of Net growth	Annual-carrying charges Percent	Annual-carrying charges Dollars Per M'
	In.	Bd. Ft.		Dol's.	Dol's.	Dol's.	Pct.	Pct.	Pct.		
4C	35	1,761	1-3	23.72	17.28	6.44	.4	2.7	-2.3	5.3	.34
4A	32	1,630	1-2	23.57	17.38	6.19	.5	.4	.1	2.9	.18
3B	27	844	1-5	22.00	17.75	4.25	.9	1.0	- .1	3.1	.13
3B	28	1,178	3-5	19.37	17.49	1.88	.8	1.0	- .2	3.2	.06
2B	22	675	4-4	19.79	18.86	.93	1.6	.6	1.0	2.0	.02
2A	19	319	4-4	19.75	21.16	-1.41	2.5	.2	2.3	.7	None

* Exclusive of road construction costs, profit, loss, and stumpage.

TABLE 2

MATURITY SELECTION SYSTEM MARKING SCHEDULE

Assuming a 50 Percent Cut for a Typical Central Oregon Tract in 1941 Showing the Minimum Diameter to Which Trees of Each Tree Class and Log Grade Composition Should be Cut

From a Timber Stand Analysis by Donald Bruce

Keen Tree Class	Log Grade Composition * 1-1	1-2	1-3	1-5 or 2-2	2-3	2-5	3-3-3 or 4-4-4	3-3-5 or 4-4-5	3-5 or 4-5	5-5
	Minimum Diameter at B.H. to Which Trees Should be Cut—Inches									
1 & 2	- †	-	-	-	-	-	-	-	-	-
3A	27	29	38	43	-	-	-	-	-	-
3B	24	25	31	33	-	-	-	-	-	-
3C & D	20	21	23	24	27	-	-	-	-	-
4A	All	All	All	All	33	45	-	-	-	-
4B	All	All	All	All	24	30	38	-	-	-
4C & D	All	All	All	All	All	All	All	All	34	

* "1-2" signifies that butt log is grade 1 and that the second log is grade 2.

† A "dash" signifies that there will be no cutting in this class and log grade composition.

TABLE 3

Stand Statistics for Five Assumed Cuts Whose Order of Cutting is According to Magnitude of Carrying Charges

Order of cutting	No. of trees	Av. tree volume	Av. sales value	*Av. Costs per M.	Av. marginal value	Pct. total marginal value	Av. gross growth rate	Av. mortality rate	Av. net growth rate	Net annual carrying charge
		Bd.Ft.	Dol's.	Dol's.	Dol's.	Pct.	Pct.	Pct.	Pct.	Dol's.
1st 20%	14	2.319	24.62	16.88	7.74	45.6	.33	2.3	-2.0	5.0	.39
2nd 20%	16	2,039	23.00	17.28	5.72	33.8	.47	1.0	- .5	3.5	.20
3rd 20%	21	1,545	20.32	17.44	2.88	16.9	.63	1.1	- .5	3.5	.10
4th 20%	31	1,026	19.43	18.07	1.36	7.9	1.02	.7	.3	2.7	.04
5th 20%	66	465	19.21	19.96	- .75	- 4.2	1.49	.9	.6	2.4	None
Tot:100%	148	1,081	21.35	17.90	3.45	100.0	.78	1.2	- .4	3.4	.12

* Exclusive of investment in roads, profit, risk, and stumpage.

capital investments yielding that much interest.

4. The capital value of each tree as it stands, i.e., its lumber realization value less cost of falling, logging, and milling on a per thousand feet basis.

When the first three elements are combined and applied to the capital value of the trees we have a net cash cost for carrying that tree which takes into account its rate of growth, its chances of surviving bark beetles, etc., and its present value on the stump.

An illustration (table 1) will help to clarify how these four elements are derived and combined, using a half-dozen typical, but quite contrasting, trees from an actual study plot.

One of the tenets of this system is that it is not good forestry in this type to cut the ponderosa pine trees that will not pay their way to and through the mill, that is, the negative value trees. They are not occupying valuable room that justifies paying hard cash to remove them, they may have a price increment that will justify harvesting them later, they are doing no silvical harm to the forest, and may do some good.

The criticism is sometimes made by those who do not thoroughly grasp the significance of the combination of these four elements or who do not mentally subscribe to Dr. Schenck's dictum "it is the best forestry that pays the best in the long run", that the maturity selection system is just economic selection or "high-grading." Such an interpretation fails to recognize the differences between taking out a tree because it will yield a good revenue and taking out a tree because it is costly to hold on account of low net growth and high carrying charge, i.e., economic and biological maturity.

This method would not be sound forestry were it not for the fact that in these pure ponderosa pine forests high intrinsic value and biological maturity are coincident much of the time. The big, old, often stag-topped yellow-barked trees are the ones that have the high-quality lumber, and their mortality probability often offsets their growth. From every point of view they are the trees to cut first. If we had measures of growth rate, of mortality probability, and of marginal value that were absolutely reliable for every tree the marker could apply this formula and fix an order of priority for cutting of every tree with a good deal of assurance. As it is we have to deal in averages in making up a marking rule and group the trees that are to be cut according to certain specifications of size, tree class, and log grade composition. Such a rule can only be made after study of the structure, growth, and health of the local timber, because the distribution of the various size classes, tree classes, and log grades varies greatly from place to place, (as you all know,) and after the decision has been made what percentage of the volume will be taken in the first cut.

Donald Bruce, of the consulting forester firm of Mason and Bruce, recently made up such a rule for a tract of timber in central Oregon, based on a 50 percent cut by the maturity selection system. This rule (presented in table 2) shows, for example, that no class 1 or 2 trees will be cut; that class 3A trees with a log structure of 1-1, i.e., both the first and second log of No. 1 grade, will be cut if over 27 inches in diameter; that the 3A trees with a 1-3 log structure will be cut only if over 38 inches in diameter; and that all the 4C and 4D trees will be cut except a tree under 34 inches in diameter with a 3-5 or 4-5 log structure, an unusual type of tree. Since it is very difficult for the marker to carry in mind a marking rule that embodies so many elements, Mr. Bruce thought of the idea of putting the rule on a Biltmore stick. He has made a stick for field use on one face of which is given the rule for the class 3 trees, on the other the class 4 trees. The diameter limit to which a tree of each log grade content should be cut is indicated at the appropriate point on the Biltmore stick.

As just stated, if we could get a perfect growth, mortality, and carrying charge rating for every tree there would need to be no exceptions to the

rule. But having to deal with a rule that applies to the average tree of its class there must be some exceptions—perhaps a 3B tree that is a leaner or a twin, class 2 trees that ought to be taken out of a thicket to give release, or a class 3C or 4 tree that under the rule should be cut but must be left to avoid making too big an opening. The skillful marker will perhaps not want to divert from the strict application of the marking rule for more than 10 percent of the trees. Needless to say, marking under the maturity selection system requires a far higher degree of skill than marking under the conventional 80 percent cut method. After there has been made a study of the local stand structure the field marker has to size up a tree for tree class and log grade, as well as diameter and any factor that might make it an exception to the rule. When only 40 or 50 percent of the volume is cut there are lots of questionable trees to be thoroughly looked over.

You may be interested in seeing how cutting by this system would really work on paper for a specific tract. We have here an analysis for a 7½-acre plot on the Pringle Falls Experimental Forest which contains 148 trees that have been carefully measured, classified, and log-graded and their value, net growth rates, and carrying charges computed as we showed a few minutes ago.

When these trees are arranged in order of priority of cutting, according to the formula just explained, and then divided into five groups of equal volume from the top down, they show (table 3) striking differences.

As a sequel to the revolution in logging methods and as a consequence of the silvical, entomological, and economic studies that have been made of ponderosa pine management, a very large amount of light cutting is being done in Oregon and Washington. Not all of this follows, by any means, the full principles of the maturity selection system. On the national forest timber sales, the selection of trees for cutting is based on tree class, regardless of present stumpage value, together with strong emphasis on mortality probability (or insect susceptibility) and thriftiness or lack of it. A few instances will illustrate the present practices and trends in pine silviculture in Oregon and Washington.

1. On the Malheur National Forest the pioneering experiment in 40 percent maturity selection cutting was begun in 1936 on the big Hines Lumber Company timber sale. It was a success and ever since then all the government timber cut there has been on a basis that leaves about 60 percent of the merchantable volume standing. The cut amounts to approximately 80 million board feet a year on this basis. The selection of the trees for harvesting on this and other national forest sales does not follow in letter the principles of the maturity selection system but puts the emphasis on the biological factors—thrift and susceptibility to bark beetles—rather than on the economic factors—value and cost of holding.

2. On the Deschutes National Forest pre-cutting exchange agreements have been made with the two large companies operating out of Bend—Shevlin-Hixon and Brooks-Scanlon—whereby the Forest Service marks for cutting both the company and the government lands providing for a 50 percent reserve. Thus, in this territory about 150 million feet are cut each year, leaving about a township of cut-over land in excellent growing condition, with about this same volume of standing trees upon it.

3. On the Whitman National Forest there is another 45 million feet a year cut by this light marking method, part of it from lands formerly privately owned and taken over by exchange.

4. On other national forests in Oregon and Washington there is cut each year on the light selection basis another 50 million feet or so; in the latter State conditions seem to require a somewhat heavier cut than in Oregon—perhaps about 60 percent.

5. The Indian Service likewise is employing on its timber sales on the reservations a lighter cut than heretofore, which parallels closely the principles of the maturity selection system. On the Klamath Indian Reservation, in the

face of severe insect depredations, this modernized form of excellent forestry involving about a 60 to 70 percent cut based on tree class, beetle hazard and size selection is being practiced on some 20,000 acres a year involving a cut of some 175 million feet.

6. The Klamath Falls operation of the Weyerhauser Timber Company is conducting an interesting experiment in very light marking—13 percent or so —by a system called the sanitation-salvage system, on areas of high insect hazard. While this method differs in principle from the maturity selection system, it is a most appropriate and progressive procedure where there is a great threat of insect activity. By this method some 5 million feet of trees will be cut this year, well in advance of the main operation where there is a grave probability of there being serious bark beetle losses.

7. Another private operation merits special mention as an exponent of the new developments in pine silviculture —the J. Neils Lumber Company. On its Klickitat operation it adopted in 1939 in toto the maturity selection principle of cutting and is now harvesting annually about 30 to 35 million feet on a 50 percent cut. These are but a few examples of the revolution in pine silviculture.

Thus, in these many logging operations in eastern Oregon and Washington on public and private lands two-thirds of a billion feet per year are being cut on a lighter basis than heretofore. This results in an area of perhaps 100,000 acres of cut-over land being left annually in a condition silviculturally superior to the land logged heretofore in the following particulars:

1. More of the productive forest capital is left standing and the non-productive is retired in logical order.
2. Each operating unit is more quickly converted from the stagnant to the growing condition.
3. The mean annual increment is larger.
4. Trees which otherwise might die and be a total loss are salvaged.
5. The hazard of bark beetles and wind is lessened and the danger of fire better controlled.
6. Forest conditions and the indirect benefits of forests are better conserved.
7. The entire working circle is more quickly put under management for protection and salvage.

Tuberculin Testing in High Schools: Its Educational and Preventive Value

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In recent years the tuberculin skin test has become an important factor in the campaign against tuberculosis. The test has been criticized, as a case-finding procedure, the claim being made that relatively few cases of active tuberculosis are discovered by this method. This is quite true, and if evaluated from the standpoint of case-finding alone, the tuberculin testing program would be very expensive and not nearly as effective as some other methods.

The value of the tuberculin testing program also depends greatly upon the type of community in which the work is carried on. In congested city districts, or in other localities, where the percentage of positive reactors to the tuberculin test is more than one-third of the total number tested, it is generally conceded that mass x-raying of the entire group to be investigated is preferable to doing the preliminary tuberculin tests and then x-raying all the positive reactors. In smaller towns and rural communities, however, where the percentage of positive reactors to the skin test is around 15%, or lower, the procedure of doing the tests first, followed by chest films of the positive reactors, is still a feasible and effective

method, particularly from the educational and preventive standpoints.

If the tuberculin testing program is carried on primarily for its educational and preventive value, then the educational element in the program should, of course, be emphasized . Thorough preliminary work should be done in each high school a short time before the date for the actual testing itself. This preliminary program usually includes the following:

1. A general talk on tuberculosis before the student body by a trained tuberculosis worker.

2. Showing of one or more films that give dependable information concerning tuberculosis and its prevention.

3. Having each student fill out a brief questionnaire, giving information as to his past health record and also whether or not he has had any definite contact with tuberculosis.

4. Have each student take home a mimeographed sheet which explains briefly to the parents the purpose and value of the tuberculin test. This sheet has, at the bottom, a consent slip which the parent signs and this written consent of the parent is turned in at school by the pupil before the tests are given.

In doing the actual testing we do not place emphasis on mere speed in getting the tests done, but take time to answer any questions, brought up by the students, and also to explain different points as we go along. This is also supplemented by the giving of additional information when we read the tests. We now have a small mimeographed sheet—one for positive reactors and another for those who are negative to the test—giving a brief explanation concerning the reaction to the test, and one of these explanatory sheets is sent home to the parent in the case of every student tested.

Following the reading of the tests, which is done approximately forty-eight hours after the tests are given, the physician has a personal interview with each student who had a positive reaction to the test. This includes a chest examination, as well as a brief check-up of the general physical condition—teeth, throat, general nutrition, etc. The main objective, however, in having the interview, is to explain to the individual student somewhat more in detail the significance of a positive reaction to the tuberculin test; urge these young people to follow good general health habits; advise them to have an x-ray film of the chest to be sure the lungs are approximately normal; and also stress the importance of re-examinations (including x-ray of the chest) at reasonable intervals in succeeding years. The School Nurse, or Public Health Nurse, also makes a home call wherever a boy or girl has had a positive reaction to the tuberculin test and gives information to parents in regard to the significance of a positive reaction. Those negative to the skin test, and this means about 85% of those tested in small towns and rural communities in the state of Washington, are advised to have the test repeated at least every other year until the individual is twenty years of age or older. This is on the assumption, of course, that the test has remained negative.

If a tuberculin-testing program is carried on along the general lines indicated above, we feel that it is a very valuable procedure, and one that should be of great help to this group of young people who in a few years will be heads of families and the homemakers in our various communities. These individuals should not only be able to apply this knowledge in the prevention of tuberculosis in their immediate families, but also be a source of dependable information concerning tuberculosis and its prevention for neighbors and others in the community.

The tuberculin-testing program, under consideration here, was started in the fall of 1931, so covers a period of approximately ten years. The great majority of the tests have been made with Old Tuberculin in the medium dilution of 1 to 1,000. Two strengths of P.P.D. have been used in a few localities and for a total of something over 1,500 tests. The tests, done with medium-strength Old Tuberculin (1 to 1,000 dilution), were made only once, not being repeated with a stronger di-

lution. We have felt that, from the educational standpoint, it is more effective to test say 10,000 students once than to test 6,000 with a weak solution and then have to re-test some 5,000 of the same people (about 85% negative reactors) over again. There is, of course, some element of error in doing the tests only once, and with a medium-strength solution, but an individual who actually has an active tuberculosis lesion should, in the great majority of cases, react positively to this medium-strength dilution of Old Tuberculin. It is taken for granted that the solution used in making the tests is freshly prepared, the full-strength tuberculin secured from a dependable source, the test carefully done, and accurately interpreted.

It should be very definitely and frankly stated that this single-dose method of doing the Mantoux tuberculin test is not as accurate and dependable as the two-dose method. In institutions such as colleges, universities, nurses' training schools, etc., where time and personnel are available for the additional testing, the two-dose method is decidedly preferable and should be employed. It is also true that the incidence of clinical tuberculosis is somewhat greater among these young adults than in high school groups, so the testing of these older people should be as accurate as possible.

On the other hand, in the report of the Sub-Committee on Case-Finding Procedures in Tuberculosis *—of the American Public Health Association—this Committee states:

"In the meantime it should be noted that the great majority of all patients with clinically significant tuberculosis as defined above, react not only to all the well-known types of tuberculin, including both Purified Protein Derivative and the various well-known brands of Old Tuberculin, but to small doses of any of them."

There has been a slow, but definite, decline in the percentage of positive reactors during the past ten years. The results for different periods are as follows:

	Tests	Positive	Per cent positive
Sept., 1931 to April, 1935	17,191	2,356	13.7 %
May, 1935 to May, 1938	15,929	1,890	11.86%
June, 1938 to May, 1941	17,509	1,759	10.04%
Total	50,629	6,005	11.85%

It will be noted that the drop in percentage of positive reactors, from 1935 to 1938 was 1.84%, while the drop, from 1938 to 1941 was 1.82%.

It should be remembered that no city children are included in these groups. Tests in Seattle, Spokane and Tacoma have been done by tuberculosis organizations and local health authorities in those cities.

As a comparison, the results among younger children (junior high and lower grades) might be of interest. During the past ten years the following results have been noted:

Junior High and Lower Grade Pupils—

	Tests	Pos.	% pos.
Sept., 1931 to April, 1935	8,026	867	10.8 %
May, 1935 to May, 1938	13,156	1065	8.09%
June, 1938 to May, 1941	15,967	889	5.56%
Total	37,149	2821	7.59%

also said he felt that every high school pupil should be examined for evidence of tuberculosis at least once during the pupil's high school course.

We have not had the necessary personnel to carry on a systematic follow-up, in later years, of these boys and girls who were positive to the tuberculin test while in high school. The cooperation of School Nurses, County Public Health Nurses, Health Officers and Family Physicians has been utilized as much as possible in getting periodic re-examinations for these young people. There has been a cer-

During the ten-year period a total of 4,497 college students were tested, with 874, or 19.43% positive. Teachers given the tuberculin test during the same ten years totalled 3,904, with 1,470 positive —37.65% of the number tested.

Comparison of these four different age groups shows very definitely the increase in percentage of positive reactors with increase in age of the group tested.

It is well known that the incidence of clinical tuberculosis among students of high school age is very small. Doctor Henry Chadwick † of Massachusetts reports the testing of 60,000 pupils in Middlesex County over a five year period. Positive reactors averaged 20%, or a total of approximately 12,000 positive to the skin test. Only one in 1,500 pupils tested were found to have active tuberculosis (40) cases. Crimm,** of Evansville, Indiana, tested 12,353 high school students over a period of eight years, using Old Tuberculin up to a dilution of 1 to 100. Of this group, 18% were positive to the tuberculin test, but only 0.1 of one per cent had active pulmonary tuberculosis. Doctor Chadwick stated that the tuberculin tests could be used most advantageously, as a screening process, in schools and colleges where the percentage of positive reactors is less than 30%. He tain small percentage of cases, of course, that have broken down with active pulmonary tuberculosis, either while in High School or in succeeding years. Our general observation has been that the number of active cases, developing in this group, has been very small, and we also feel that the likelihood of a physical breakdown, because of active pulmonary tuberculosis, will be definitely lessened among these positive reactors as a result of the educational work carried on in connection with the tuberculin-testing program in the high schools. As indicated above, the home call, made by the Public Health Nurse, helps toward making clear to the parents the significance of a positive reaction to the tuberculin test, and usually enlists the co-operation of the parents in trying to keep these young people in good health.

The tuberculin skin test should never be considered primarily as a case-finding procedure, but its use should be supplemental to other well-established and more effective methods of case-finding. Considered from its educational and preventive aspects, we feel that the tuberculin-testing program among high school pupils and young adults, if properly presented, carefully done, and with as thorough follow-up as possible, is a procedure in tuberculosis control that is worthy of continuation and expansion.

References—

* From "A Manual of Tuberculosis Case-Finding", p. 24. National Tuberculosis Association, 1940.

† Chadwick, Henry. From Massachusetts Tuberculosis League Bulletin, December, 1940.

** Crimm, Paul D. Diseases of the Chest, 7, 378—November, 1941.

Tastes and Odors in Drinking Water

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The literature on this subject runs into vast quantities, covering the causes, control methods and possible remedies, yet it remains one of the most difficult problems in water treatment and purification. The problem of producing a clear, soft and bacterially safe water has been pretty well solved, but that of palatability still defies the utmost efforts of research workers and experts in many instances.

The problem is complicated because very little is known about the compounds responsible for tastes and odors. We refer to water as having an algae, musty, or fishy odor, yet we have no idea as to the compounds which produce these odors.

There are many compounds responsible for objectionable tastes and odors in our public water supplies, yet the chemist probably cannot name five that have been identified as responsible for the more prevalent tastes and odors in water. Exclusive of the chlorinous taste, it is doubtful if the exact chemical compounds responsible for 1 per cent of them are known.

There seems to be nothing which works upon the disposition and imagination of the customers so much as a taste or odor in the drinking water. Many people still entertain fantastic superstitions concerning chemically treated water and its possible physiological effects and a taste of any kind in the water makes even those who do not ordinarily do so, feel apprehensive of some harmful effect.

The taste producing substances in water are so minute in quantity that they could scarcely be harmful even if poisonous, which they apparently are not. It has been definitely demonstrated that the sense of taste or smell is capable of detecting one part of oil of peppermint diluted in four hundred million parts of water. The chlorophenol or medicinal taste produced sometimes by chlorination can be detected in even a much greater dilution. So when we sometimes conclude from the taste that the operator has cast aside all restraint in the matter of the amount of chlorine used, there is in reality but one molecule of the chlorophenol compound in several hundred million molecules of water.

Sources of Tastes and Odors.

Plant growths of the algae type are the most common sources of tastes and odors in water supplies. Some of these organisms, if allowed to complete their life cycle, or if killed after attaining some growth, exude oils or decomposition products which impart a disagreeable taste to the water. Decaying vegetation, such as leaves, grass and moss, is often a contributing cause. These elements are particularly evident when rivers or reservoirs are low, and in swampy and stagnant areas. The above are the sources of most of the tastes encountered in the Lewiston supply.

Very severe and troublesome taste and odor conditions are often due to industrial waste pollution from such industries as coke plants, chemical plants, canneries, tanneries, oil refineries, dairies and creosoting plants. These are not so frequently encountered in less highly industrialized sections of the country.

An accurate knowledge of the sources of tastes in a water supply is of course necessary before intelligent treatment methods can be instituted by the water works operator for preventing or correcting the undesirable condition. With surface supplies such as streams and lakes, field trips along the shores of the stream or lake, made carefully and with a thoroly worked out methodical plan, will reveal much. Samples must be taken for microscopic examination, analysis, and other recognized laboratory follow up work.

Algae and the products of decaying vegetation and organic matter have been the sources of the tastes encountered in our Lewiston supply the past two years. Previously it was a medicinal or chlorophenol taste. The period

of tastes comes in the late summer when the water is low and the plant growth is at its height. Our supply comes from the Clearwater river and is treated and filtered.

The Term "Algae"

The following definition of algae is given by George C. Whipple in his book "Microscopy of Drinking Water": "The term 'algae' is used to cover several phyla of primitive plants, capable of elaborating their own carbohydrate supply by means of photosynthesis, usually without differentiated vegetative structures. Most of them live entirely submerged in water, and several groups, including the most highly developed in their vegetative structures are almost exclusively marine. They are found floating freely at the surface, attached to stones or clinging in gelatinous masses to the submerged portions of the more highly organized aquatic plants. A few prefer damp situations in which they do not become immersed at all, or only periodically become covered with water." Practically all that is required by these organisms for growth in water is carbon dioxide and sunlight, consequently they are very plentiful. They will grow in any clear water suitable for a water supply when exposed to sunlight.

Tastes Produced

The types of tastes produced by these plant organisms can be roughly classified in the following manner:

Earthy and fishy odors are caused by diatoms and some of the green algae.

Marshy or swampy odors by the green algae.

Aromatic or geranium odors by the diatoms.

Some of the protozoa cause such odors as candied violets and others a ripe cucumber, bitter or muskmelon taste.

The character of these tastes or odors change with the varying concentrations with which they are present in the water. The first noticeable odor of diatoms is earthy and as the intensity increases, it becomes aromatic and then fishy . The fishy odor noticeable when a stream recedes quite rapidly from its higher stages is usually caused by exposing to the air and killing the diatoms which were growing on the bottom along its shore lines. Some even ascribe the fishy odor of fish to the diatoms which are an important source of food for them.

Tastes Caused by Chlorine

The most troublesome and persistent taste encountered in chlorinated supplies is a medicinal or iodoform taste. This taste is easily detected in even greater dilution than one part in four hundred million, as before mentioned. It cannot be boiled off, but ruins both tea and coffee. It cannot be hidden by lemonade or punch, but seems even worse when the water is used in these drinks. Ice made from water containing this medicinal or chlorophenol taste carries it full strength. People frequently mistake this taste for that of chlorine which is quite different and some think iodine has been put in the water.

The substances or chemical combinations entering into this reaction with chlorine are not well known except that phenols and organic substances in solution will cause it. The chlorine dosage must also be sufficient to produce a certain oxidation potential. Among the possible remedies for chlorophenol or medicinal tastes, one of them, strangely enough, is chlorine.

Control Methods

One of the boldest and most sensational remedies for tastes and odors in drinking water has been the use of chlorine. Chlorine itself has been one of the worst offenders and yet it is one of the most successful remedies. The solution has been not less chlorine, but more, a great deal more. This method is called super-chlorination or break-point chlorination. Enough chlorine is added to the water to completely oxidize or burn up the taste producing substances. A dechlorinating agent is then used to remove the excess chlorine if any and the taste is gone, leaving the water fresh and clean.

I would like to tell you briefly of a classic instance where this treatment

was used. I believe you will find it interesting.

Ottumwa, Iowa, with a population of about 3500 is located on the Des Moines River, 107 miles down river from the state capital of Des Moines. Ottumwa gets its water supply from the Des Moines river. In the winter of '39 and '40 the river reached a very low stage. Des Moines was discharging 14 million gallons per day of raw sewage into 12 million gallons of natural river flow, so that the river was more than half raw sewage.

Severe weather froze the river over with a solid sheet of ice 15 to 18 inches thick, which was covered with a heavy blanket of snow, thus forming a closed conduit from the Des Moines sewers to the raw water intake at Ottumwa. Septic conditions immediately set in and you can readily imagine the odor and condition of the water supply at Ottumwa.

It was a desperate situation and called for strong measures. Break-point chlorination was decided upon when nothing else gave results. It was necessary to feed chlorine from twelve one-ton containers at one time to get sufficient chlorine into the water for results. The colossal amount of 934 pounds of chlorine were used in each million gallons of water. This combined with the organic matter present and formed a precipitate which resembled clotted blood. After sedimentation and filtration the water came out clear and sparkling with no taste except for a very slight and unobjectionable woody taste. The papers referred to this treatment as "Super-Colossal Chlorination." Ottumwa can surely boast of some very brave men in the water department.

In Lewiston we have eliminated the chlorophenol or medicinal taste which troubled us in the late summer and fall seasons by the use of chloramines. Ammonia is added first and as soon as this is thoroly mixed, the chlorine is applied, the two forming what is called chloramines. The ammonia prolongs the sterilizing effect and reduces the oxidation potential of the chlorine preventing the formation of chlorophenols or other taste producing compounds.

Activated carbon has been used successfully in many places, but has proved rather expensive in some instances. The carbon absorbs the tastes or odors and is then filtered out. An interesting fact concerning powdered activated carbon is the tremendous surface area it presents to the water. A single cubic inch of it has been calculated to contain twenty thousands square yards of surface, an almost incredible amount. However, when you get a speck of it on you and try to wipe it off, it seems to go about that far.

This matter has of necessity been dealt with in a sketchy manner, but if this outline has given you a few of the things the water works operator is up against in respect to this problem, it has served its purpose.

BOOK REVIEW

THE PACIFIC NORTHWEST—John Wiley and Sons, New York, 1942.
Editors, Otis W. Freeman and Howard H. Martin

For the first time a thorough-going book on the resources of the Pacific Northwest is available to educators and laymen. This new book is the product of 30 specialists in the fields of resources, all of whom are living and working in the Northwest. The contributions of these thirty were integrated into a usable volume by the two-man editorial committee, both men being well known for their individual contributions to geographic study of the Pacific Northwest Region. While each chapter is a unit in itself, it is also a block in the pattern of resource information, making the new book a comprehensive account of our western region.

The book is interesting to read just for enjoyment. It opens with a chapter on Indian life of the Pacific Northwest, which upon reading stimulates interest in knowing more about the early inhabitants of our present home land. The second chapter takes up the early pioneers. While this book is essentially geographic in point of view, it is an excellent example of the fact that the history, the geography, the geology, the economics, the sociology, and to some extent the psychology of Northwest development cannot be separated when the complete story of our land is told.

542 pages contain a great store of verified data regarding the resources of the western states, something of western Canada and Alaska. In addition to the page content, there is tucked in a handy pocket on the back cover of the book a landform map three feet by two feet. This map helps to visualize some of the chapters which discuss the great variation in topography found in the Pacific Northwest.

An outstanding feature of the book is the large number of up-to-date pictures, diagrams, charts and small maps which illuminate the written discussion. The pictures are not just fillers to catch the eye, but are genuinely a part of the book.

This book is of value to several groups of people. It will be used extensively by college teachers and students, by planning councils and other social research groups. The book should be in every school library as a source reference. It should be easily available for elementary teachers to use for their reference in gathering suitable materials for study of conservation, the life of western people, the development of our own state and many other similar topics.

There is a complete indexing of materials which greatly helps in finding specific items. Following each chapter is a selected list of usable references, most of which can be found in the libraries of the Northwest.

The Pacific Northwest will be of great value in the study of the history of the State of Washington, as now required by law in our state.

The writing of this book was aided by a grant from the Trustees of the Northwest Regional Council and the contributions of the thirty resource specialists were made as a professional service for educators and others interested in the great Northwest. Members of the Northwest Scientific Association who contributed to the volume are: C. E. Deardorff, O. W. Freeman, A. L. Hafenrichter, C. S. Kingston, H. F. Raup, H. H. Rhodes, W. A. Rockie, R. M. Shaw, J. B. Appleton, E. T. Hodge, W. B. Merriam, W. D. Smith, S. N. Wyckoff, and J. D. Forrester.

H. F. HAWK.

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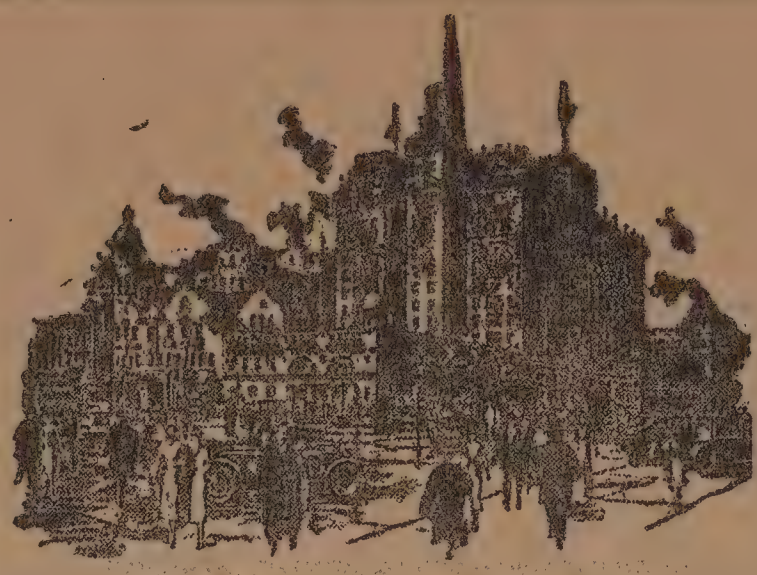

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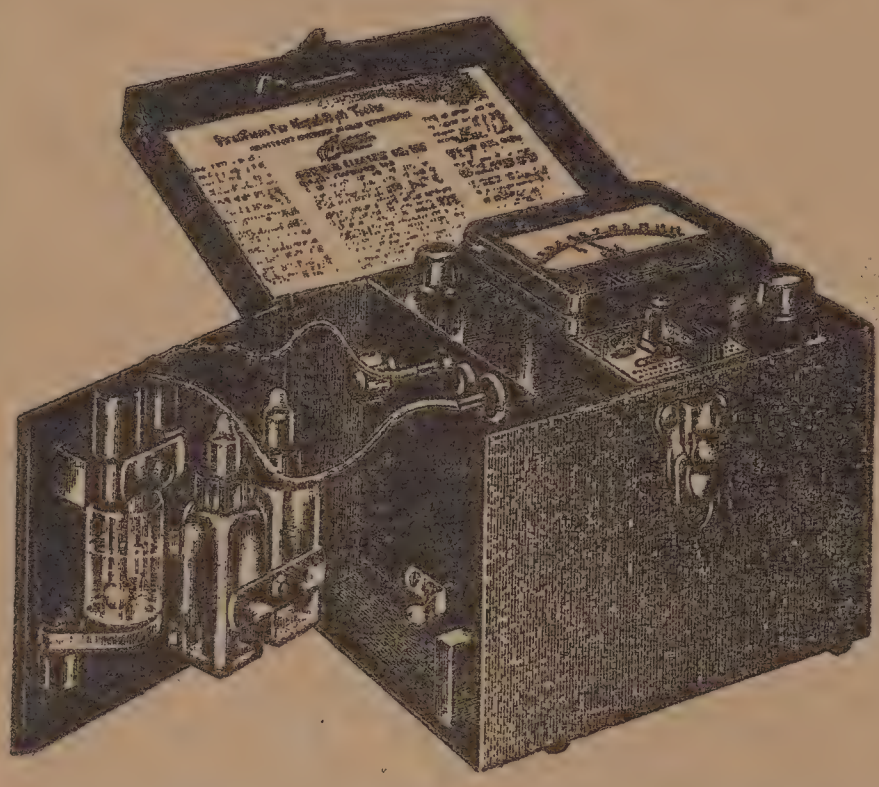

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-:- NORTHWEST SCIENCE -:-

Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes 1 to XV, 1927 to 1941, each $1.25.
All Fifteen Volumes, $15.00

Editor, Otis W. Freeman, Cheney, Washington

VOL. XVI, NO. 3 **AUGUST, 1942**

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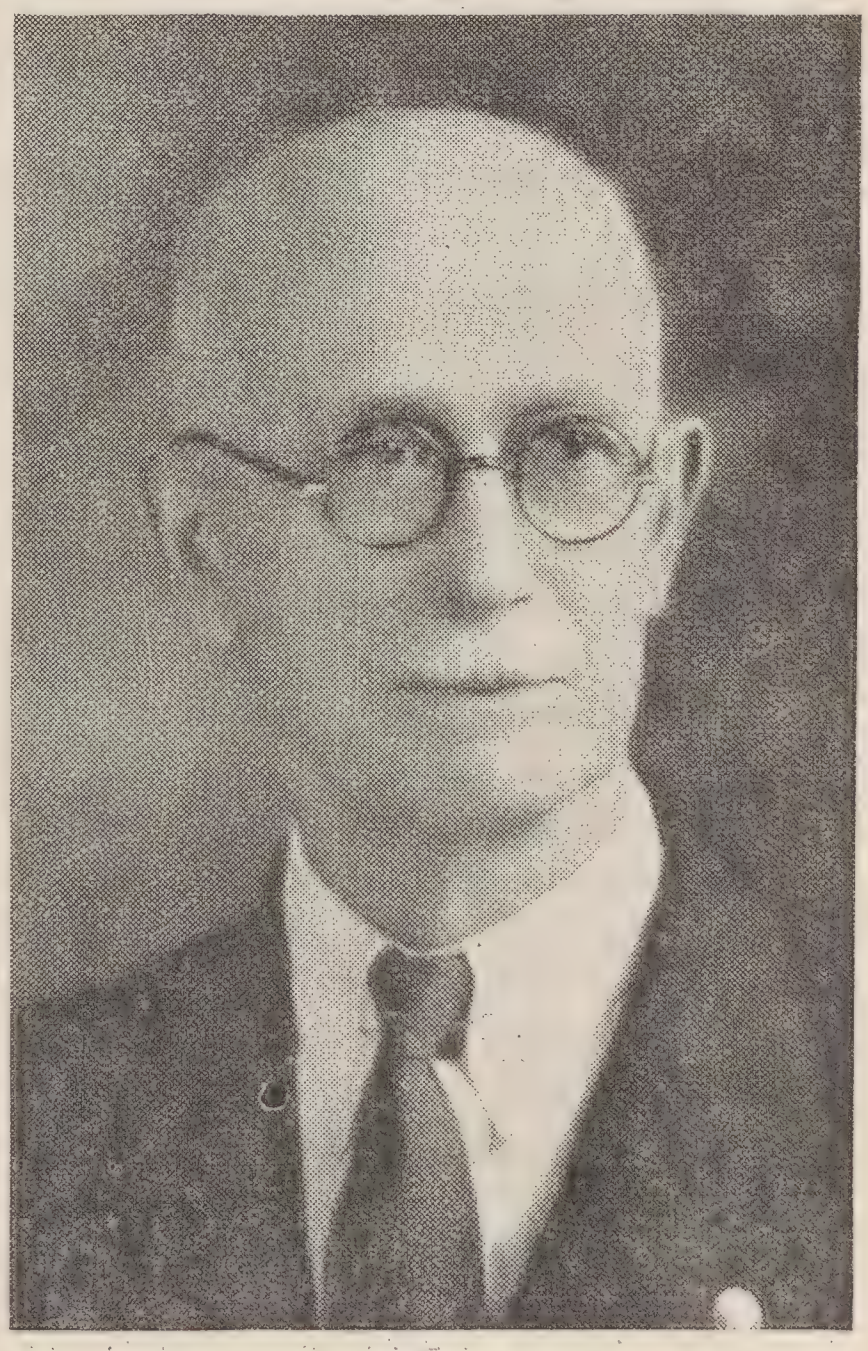
LYNDON K. ARMSTRONG

1860 - 1942

Mr. Lyndon K. Armstrong died June 21st at his home after being in declining health for about a year. Mr. Armstrong was 82 years of age, had been a consultant mining engineer and resident of Spokane for 50 years and was one of the founders of the Northwest Scientific Association. For many years he was a member of the board of trustees of this society and had served on the editorial board of Northwest Science and in numerous elective offices. In recognition of the services rendered, a few years ago he was made a life member of the organization. Ever since the publication of Northwest Science, Mr. Armstrong had distributed from 100 to 125 copies of the publication to exchanges all over the world.



"L. K." will be missed at the annual meetings of the Northwest Scientific Association where he always met the members as they arrived with a hearty handclasp and a request that they register.

Mr. Armstrong was born in Wisconsin and came to Montana in the days when the buffalo still roamed the bunch-grass plains of that territory. In early days he published the magazine called "Mining" and was connected with other mining publications in the Northwest. Mr. Armstrong had accumulated probably the finest private science library in the Pacific Northwest. For years, this was housed in his offices in the Peyton Building and anyone who needed information was welcome to consult it. It is understood that the library will go to the State College of Washington at Pullman.

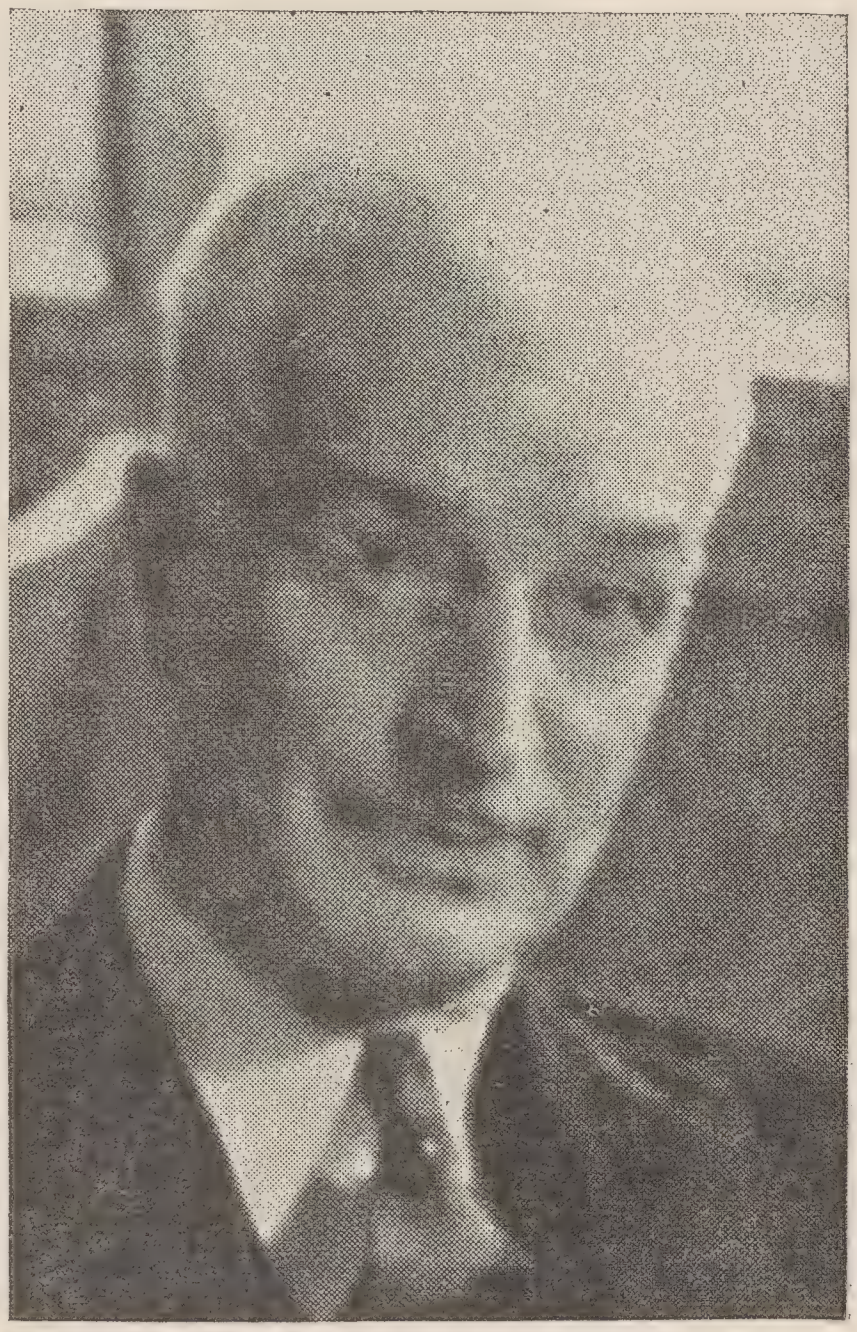
Mr. Armstrong is credited with being the founder of the Columbia Section, American Institute of Mining and Metallurgical Engineers. He was also a charter member of the Associated Engineers of Spokane and a member of

many other organizations. He was consulting engineer for Hugh Cooper in his various Z Canyon enterprises. His personal mining interests, while diversified, have, in recent years, been mainly in the Metalline and Northport districts in this state. Mr. Armstrong became widely known because of his assistance in finding college graduates places in the mining industry.

Surviving are: his widow, at the home; two daughters, Mrs. Marion Cryor and Mrs. Helen Myers, Spokane; and one son, Holbert Armstrong, Seattle, now in the advertising business on the coast. The members of the Northwest Scientific Association were all his friends and will genuinely mourn the passing of one of the founders of our organization and the dean among the mining engineers of Spokane.

JEROME HINDS RAMSKILL

1881 - 1942



Northwest science in its various fields has lost one of its most active and constructive workers. 'Jerry' Ramskill passed away at his home early in the morning of March 31, 1942. He passed away as he had always lived—quietly, easily and with a smile of recognition on his lips for those whom he loved. Northwest Science has lost a real friend and a hard worker. For many years he worked with our Association he gave it his all. A true scientist, not only in his endeavor to develop a finding attitude in his co-workers and his students, but also within himself. Would there were more "Jerry Ramskills" in the rich fields of northwestern research and scientific education.

He was born in Chicago, but early in his life he moved with his family to the Chesapeake Bay region where he spent his boyhood and young manhood. Chesapeake Bay knew him well. He attended Cornell and Yale of Forestry. For eleven years after graduation from Yale he practiced his profession with the United States Forest Service in Colorado and adjacent states. During the first World War he was called to Burma to assist in the production of teak and other tropical timbers for the war work. He spent four years in Burma and then returned to the United States. Immediately afterwards he was persuaded to become a member of the staff of the School of Forestry at Montana State University, and in his twenty-one years' membership with that staff to him was granted the recognition of being a true scholar and a real teacher. His sincerity of purpose was manifest to all. A living example of all that is best in a teacher and in a worker, he was an ideal for the undergraduate student.

He is survived by his wife, Bernice, and a sister, Emily, of New York.

The passing of Jerry Ramskill removes a man who in all ways was true to his profession and to his own fine ethics and high standards of service.

Professor Ramskill was an active member of the Northwest Scientific Association from its inception. He was generally in attendance at the meetings and could be always counted upon to present the results of his research before the forestry section. He served as chairman of the Forestry Section and as president of the Northwest Scientific Association during 1938.

He was the recipient of grants from the Association to aid his research on forestry problems.

RECENT DEVELOPMENTS IN WHITE-PINE BLISTER RUST CONTROL IN THE NORTHWEST

EDWARD L. JOY, FORESTER*

It was over 35 years ago, in 1906, at Geneva, N. Y., that a strange and unfamiiar disease was found on the leaves of a ribes† bush. As is often the case, this discovery might well have been only the extension of the known range of a common, native disease, or even the first finding of a previously undescribed, mild-mannered, indigenous fungus. This was not true of the Geneva collection, however, for laboratory examination revealed that once more a serious and destructive Old-World fungus had become resident in North America. The pest was white-pine bister rust (Cronartium ribicola Fisch.), a disease that had been discovered, observed, investigated, and written about in Europe for over half a century, but against the introduction of which this country did not put up quarantine barriers until 1912.

Skipping over the succeeding 15 years, which marked the organization and development of the program to control blister rust in the eastern white pine forests and the intensive searching for evidence of its introduction into the West, we come to the fall of 1921. Then, just 20 years ago, it was revealed that the West also had this disease to combat, for it was discovered to be firmly established in the forests of southwestern British Coumbia and northwestern Washington. This focused attention immediately on the extensive forests of commercial white pine in the West, particularly the stands in the Northwest, and resulted in the first western control efforts. The initial task was the development of working methods in a new country with host plants, topography, forest cover, weather, and many other factors different in the extreme from those in the East. This particular phase of the work, although relatively uninteresting to most people, actually provides the material for the behind-the-scenes or inside story of blister rust control in the Northwest.

A review of the 18 years of control efforts in this region shows that there have been three distinct periods, which were marked by varying degrees of successful accomplishment. The first period was the 10 years from 1923 to 1932, a period of preparation and slow advancement. The second period, which includes the 4 years from 1933 to 1936, was one of outstanding progress and achievement. The third and last period, which runs from 1937 to the present, is one identified with the difficult problem of holding gains already made, with a greatly reduced supply of available labor.

Quarantine enforcement, white-pine-resource surveys, experimental control work, and initiation of the Federal-State-private cooperative control program were the major activities of the first decade. Unfortunately an adequate program was not started then, even though it was well outlined and strongly urged by men who had studied the problem thoroughly to the conclusion that the disease would be generally established in this region by 1936. This prediction came true, as did another they made, namely, that unless large-scale operations were started in that earliest period and continued aggressively until all valuable stands of white pine were protected, the cost of control would increase because of the greater difficulty of controlling the disease after its invasion.

The results of this first period of 10 years, from 1923 to 1932, were initial control work on only 215,169 acres, or about 8 per cent of the 2,670,000 acres of western white pine, and rework on 6,570 acres, which is only a fraction of 1 per cent of the area.

A very abrupt change in circumstances occurred in 1933, which marked the beginning of the second period in the history of blister rust control in the Northwest, for almost overnight the Federal emergency work projects to relieve unemployment became the source of thousands of workers for this

* Read before the Northwest Scientific Association in Spokane, Washington, December 30, 1941.

† Ribes is the generic name for currants and gooseberries.

program. Although the extensive operations of 1933 and 1934 did not continue on such a large scale in 1935 and 1936, the total work accomplished in these 4 years suggested the possibility of completion of the major part of the task by 1940. During this 4-year period initial control work was accomplished on 1,405,867 acres, or 52 per cent of the total, and rework covered 70,426 acres, or 5 per cent of the estimated job. Combined with progress during the preceding decade, the cumulative totals were 60 per cent of the initial work and 6 per cent of the rework.

The hopes of carrying on in these proportions to completion of the task, were, however, short-lived, because decreasing relief loads and the demand for emergency workers on other projects of every description have, since 1937, drastically reduced the number available for this project. It is notable that the ensuing regression came at a time when two highly important developments were taking place, namely, the rapid build-up of the rust spreading from the many spearheads of infection started during the years from 1923 to 1936, and the urgent need for extensive rework on part of the large acreage covered during the second period. As a result, the efforts since 1937 have largely been centered around rework or holding the line. This has prevented that much-needed large-scale and rapid extension of control to untouched areas, although some of this has been possible. In total, about 252,100 acres of initial work and 323,100 acres of rework are the record from 1937 through 1941. In addition, further work on 170,000 acres of mature timber has been deferred until after logging because of the present low hazard to this loggable timber.

The progress of control work to date stands at about 2,043,150 acres given initial treatment or deferred status and 400,100 acres reworked. This means that the first part of the job is about 70 per cent and the second part about 25 per cent completed.

The development and improvement of control methods and equipment have been going on since the first ribes bush was uprooted in 1923. The intention is not to review the many changes and minor adjustments which have been made in these methods and procedures, but rather to point out some of the more significant developments which have taken place in the blister rust control program. Of interest in this connection is the present status of the three primary methods of ribes eradication, namely, hand grubbing, chemical treatment, and clearing with bulldozers.

On initiation of control work in and around the Clearwater, St. Joe, and Cabinet National Forest areas one of the primary problems was the destruction of the masses of the highly susceptible western black currant, Ribes petiolare, which was generally present along most streams. The eradication of this species was not possible by grubbing methods, so the use of chemicals was developed, for which specially designed portable spraying equipment was devised. Through this equipment more than 1¾ million gallons of chemical solution have been pumped in destroying this species on 22,518 acres of stream type, winding through several hundred thousand acres of forest land. The annual output has ranged from a peak of 388,000 gallons in 1934 to a mere 12,700 gallons in 1941. With the exception of a few isolated areas in the back country of the St. Joe and the Clearwater forest areas, the R. petiolare problem has been "licked" and chemical eradication has passed from a primary method of ribes eradication to one of minor importance.

A similar situation exists in connection with the special brush-rake-equipped bulldozer, which was introduced in 1933 to eradicate Ribes inerme from brush jungles in stream-bottom land. In 1940 work on the last area within the white-pine type which had to be treated by this drastic method was completed. This method accounted

for a total of 2,200 acres cleared of brush and ribes, much of which is now under cultivation growing heavy crops of hay or being used for pasture. Bulldozer work in blister rust control in the Northwest may now be regarded as a thing of the past.

These two accomplishments represent important milestones in the history of blister rust control and are more significant than indicated in the acreage involved. First, the areas treated with chemical and bulldozer were all high-hazard areas from a blister rust standpoint, capable of causing early introduction and heavy intensification of the rust; and second, the areas treated by these methods were all costly units, each acre involving from five to ten times the average cost of working an acre in the upland type.

This leaves hand grubbing as the primary method of ribes eradication over the remaining acreage. A serious problem in connection with this method has confronted control supervisors from the beginning of the work. This problem is to get the workers to remove every bush completely so it will not resprout. Workers have been furnished with various types of tools, depending upon the size of bushes which were prevalent, with which they could remove a bush properly if ordinary care and diligence were employed. This did not prove adequate, especially among the large number of relief workers, because care and diligence were not universal attributes throughout the rank and file. The breaking of bushes at the ground could not be sufficiently eliminated by supervision alone, so resprouts constituted as much of a problem as missed bushes, if not more. Checkers could find the missed bushes, but there was no possibility of their finding the hidden crowns and roots of bushes broken at or below the ground level. Naturally this was one of the principal factors necessitating rework on many areas.

Specific aid toward the mastering of this problem came from the ranks of the relief workers, when one of this group, for his own particular use, fashioned a tool in the shape of a pronged pick with long, beveled claws resembling those of a claw hammer. From this idea a claw-mattock ribes tool, which is practically foolproof in eliminating the root-crown problem, has been perfected and used during the last 3 years. The value of this tool in the battle against ribes through the great reduction in the amount of area requiring rework is inestimable. One might say that a "found" ribes is an "eradicated" ribes in the present work, which was not always the case in years past.

Less tangible than the above-mentioned developments but highly important in the general line of attack are those matters dealing with planning. This phase of the job is a year-around process requiring thoughtful and detailed attention to the multitude of factors affecting the establishment and development of white pine and ribes and, directly or indirectly, influencing the action of blister rust. The careful coordination of blister rust control work with the other elements in the white pine management program is a forward step in planning. An important contribution in this field is the publication entitled "Blister Rust Control in the Management of Western White Pine," a joint work by Kenneth P. Davis of the Northern Rocky Mountain Forest and Range Experiment Station and Virgil D. Moss of the Bureau of Entomology and Plant Quarantine.

Another element of planning which has always been important, but more so in recent years because progress of control work has not kept pace with the spread and intensification of blister rust, is the matter of "priorities," or, in other words, the question as to which areas should be worked first. This is not merely a question of relative values of the different white pine areas but a complex problem necessitating the consideration of a number of factors, including the occurrence of ribes plants and their possible increase, the amount of blister rust present and its rate of intensification, and the age and density of the white pine stand, as these are important from the standpoint of potential damage in the stand.

It can be readily seen that a great deal of information is necessary for the

establishment of proper "priorities." Many of these data are gathered in the normal course of pre-eradication surveys and eradication and checking activities. The records taken on these activities provide all the essential information relating to ribes and white pine on areas where control work has been performed and to a somewhat lesser extent on unworked areas. It has become necessary in recent years to introduce the disease survey as a method of securing essential information on the amount and rate of intensification of the rust on individual tracts. This survey was inaugurated in 1935 to secure, primarily by a system of sampling, an estimate of the amount of rust present in the region. The extensive use made of the data taken on these sample surveys has shown the importance of their place in the prosecution of any control program where the rust is as widely distributed as it is in the Northwest. In 1941 the disease survey was changed from a special project activity to one integrated with checking and performed as a definite function of each control operation.

Aside from the part which disease survey plays in determining priorities or deferred classification for areas, it will serve to provide the final answer as to when control is established on an area. It was originally expected that when the residual ribes plants, as determined by the check on an area, were fewer in number and smaller than those provided for under certain established working standards, the white pine stand would be protected. While the presence of ribes must now be considered as prima-facie evidence of present or future rust on all sites, there are many other factors influencing the disease, as indicated in the numerous instances where similar ribes populations have resulted in greatly different rust conditions. In the last analysis, the dependable answer as to whether a stand of white pine has been protected from blister rust lies in the examination of the trees for the disease.

An example of the type of maneuvering which is going on in control planning is the deferred working status accorded to all mature timber stands. Approximately 170,000 acres of this type have been so classified, and at least 100,000 acres additional, including some of pole size, will be added after more thorough inspections or surveys are made. This means that attention to the acreage of loggable timber which will suffer very little, if any, damage before harvest, must be deferred, temporarily at least, in favor of the more urgent job of protecting younger age classes, even though rust intensification in the mature stands will make the post-logging control work more difficult.

This review covers the more important recent developments in blister rust control in the Northwest. In general the objective has been to develop the most practical and efficient methods of ribes eradication and to plan the program so that the greatest possible acreage of the more valuable white pine lands may be maintained in the growing of this tree species. To aid in the fulfillment of this objective we have in the Spokane Blister Rust Control Office a special staff working on "Methods Development" and "Control Investigations." The results of their work are a continual aid to the control supervisors in the improvement of their plans and methods. In this connection several organizations that are as vitally concerned in this problem as the Bureau of Entomology and Plant Quarantine have contributed greatly to the development of these projects. These include the Forest Service of Region One, the Northern Rocky Mountain Forest and Range Experiment Station, the Division of Forest Pathology of the Bureau of Plant Industry, and the University of Idaho School of Forestry.

In conclusion, it can be said that substantial progress has been made in the blister rust control program, as indicated by the review of accomplishments in the first part of this discussion. There still remains a large amount of unfinished work, both in untouched lands and in those requiring further attention, before control is fully established. The final result, measured in terms of acreage maintained in white pine in this region, will depend on the extent of the program that it is possible to carry on during the next few years.

VEGETAL STABILIZATION OF OREGON COASTAL DUNE AREAS

Albert Arnst*

Reclamation of sand barrens is not a recent art, for world history indicates that migrating sands have been a recurrent problem and that they can be fixed and made productive. A review of the better-known examples of sand dune fixation reveals precedents for many of the control practices used today.

European dune control efforts have supplied data for similar work being carried on at present. In Egypt, the Pharaohs fought encroaching sands by building huge walls along both sides of the Nile Valley. Hollanders for centuries have been planting and nurturing coastal dunes to keep ocean waters from homes and fields. Extensive dunes have been stabilized along the Baltic and North seas. As early as 1778, France made plans for the reclamation of the vaste Landes area in Gascony, near the Bay of Biscay. This classic of textbooks, the Landes, even yet serves as a pattern for dune work; and today, even with the effects of war's impacts, it is both a well-known health resort and a well-managed pine forest. New Zealand in recent years has contributed to the science of dune fixation.

Perhaps it is the density of population and the appreciation of land values that have made Europeans the pioneers in sand reclamation. However, American history indicates several attempts at planting dunes. From 1826 to 1838, the Government made plantings of beachgrass at Cape Cod. Other attempts have been made along the coasts of Long Island, New Jersey, and the Carolinas; lake shores in southwestern Michigan were treated to prevent sand dunes from encroaching on cities.

Nearer home, we find successful results obtained in Golden Gate Park, San Francisco, where work begun in 1869 and carried through to the arboreal climax cover is famed today for its charm and beauty.

In Oregon, the United States Forest Service, as far back as 1910, carried on experimental work in the Coos Bay region, where, in later years, the Oregon State Agricultural Experiment Station also established a dune-control experimental planting, with the Army and Navy Departments cooperating. The Forest Service continued experimental work near Reedsport in 1934. Other minor plantings were made by park and highway commissions, utility corporations, and private individuals.

Studies made of the earlier plantings in Europe and in this country repeatedly indicated two facts: That all the sand barrens at one time had a vegetal cover and once were stable; and that afforestation or reforestation was necessary for final or permanent reclamation, but that the planting of primary grasses or herbs was absolutely essential in almost all instances before the planting of trees or shrubs. This was the conclusion reached by various researchers as early as 1896 and by Hitchcock of the Bureau of Plant Industry, who wrote that "The reclamation is most permanent when the dunes are finally covered with forest; hence forestation is the ultimate aim whenever possible."

Destruction of stabilized dunes results chiefly from land misuse, including such abuses as the removal of forest cover through logging activities or fires, the reduction of grass cover through over-grazing, and the drying out or drainage of sand-bottomed lakes. Natural phenomena contributing to dune formation are the unequal movement of tides and the deposit of sand by rivers, particularly near jetties or spits. One or more of these primary agents may be instrumental in starting a dune formation or a dune blowout.

Damage resulting from uncontrolled dune movement ranges from the spectacular to the prosaic. In the former class are instances where lighthouses

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* Read before the Northwest Scientific Association in Spokane, Washington, December 30, 1941.

have had to be raised in height to surmount advancing sands, where only the tops of chimneys remain as evidences of a former village, where a projecting cross was found to belong to a church built centuries ago, and where three or more fences have been built on top of one another. Encroachment and inundation of timber lands is more common and represents an economic loss, either in recreational or commercial values. In Oregon, one railroad in past years was forced to move its railroad shops, hotels and other buildings to avoid sand engulfment, and the same railroad had a serious accident because of sand drifts on tracks.

More insidious, but more far-reaching economically, is the problem common along Oregon coastal areas today, where wandering sands silt in harbors and channels, thereby preventing commercial water traffic, decreasing the run of game fish, impairing the natural drainage of coastal valley pasturelands, and making annual port maintenance costly or prohibitive. The covering of arterial highways is another damage requiring high annual maintenance costs.

In Oregon, coastal dune areas comprise some 30,000 acres and usually occur near larger streams and rivers. The principal problem dunes lie in scattered spots in Curry county, on an area near Bandon, along a sixty-mile stretch from Coos Bay to Florence, on several spits in Tillamook County, and on the Warrenton, or Clatsop Plains, area. The observations outlined in this paper relate to control work in progress at the latter location.

The Clatsop Plains dune area, in Clatsop County, extends from the mouth of the Columbia river south to Gearhart, a strip of land approximately twenty miles long and a mile and a half wide. The original project included some 20,000 acres, of which 3,000 acres were moving sand, 5,500 acres improperly grazed pastures subject to wind erosion, 6,500 acres farming land, 3,000 acres merchantable timber, and 1,600 acres cut-over timber land.

The 3,000 acres of migrating sands and the need for their stabilization was the chief reason for requesting the assistance of the Soil Conservation Service in 1935 by residents who had become increasingly aware of the impending threat in these advancing sands. A CCC work area was established in cooperation with the Oregon Agricultural Experiment Station and the Extension Service, and initial studies were made to determine the true problem and its possible solutions.

The preliminary survey showed that much original pastureland already had been destroyed and that more valuable properties were being jeopardized. For one thing, the locality was probably the most intensively developed recreational area in the Northwest and promised to become more so with planned new highway construction. Much private capital was invested in beach resorts and summer homes. Shopping communities, such as Warrenton, Gearhart and Seaside, had a vital stake in the future of the beach areas. Other values threatened were bulb and farm lands. golf courses, and Columbia river shipping.

In addition, valuable public properties were in the path of the marching sands. Chief among these were a $13,000,000 jetty on the south side of the Columbia river's mouth; Fort Stevens military reservation, then valued at $2,500,00; Camp Clatsop, a State militia headquarters, then valued at $1,500,000; U. S. Highway 101, valued at $1,700,000, and towns and villages with physical worth of at least $1,000,000. Much of Camp Clatsop, particularly the parade ground, already was damaged.

Climatic conditions were found to be apparently good for vegetal growth. The average growing season of 280 days, the mean winter temperature of 43° F., the mean summer temperature of 57° F., and the average annual precipitation of about 75 inches, occurring between late September and early June, were favorable factors. The prevalence of fogs and the 40 percent

possible sunshine ratio also helped.

On the other hand, wind appeared to be an inhibiting factor in establishing permanent vegetation. Wind velocities exceeding 50 miles an hour occurred about 38 days a year, were generally southerly, and prevailed during the winter months, moving large quantities of even wet sand with terrific abrasive effect on vegetation. Velocities of from 10 to 20 miles occurred about 100 days a year. On the average, one hurricane storm, reaching 70 miles an hour velocity with a 9-foot tide and 10-foot surf, would blast the dunes annually. The summer winds were northerly, and the fall, winter, and spring winds southerly, resulting in a shuttle movement of loose sands in a north and south direction during the year.

Soil or sand conditions were not considered optimum for vegetal growth. White beach sand, deficient in organic matter and nutrients, and subject to drift with low wind velocities, comprised much of the dunes. Only pioneer plants appeared adapted here; but the black sand farther inland, developed from beach sand through years of vegetal reaction with grasses and trees, was extremely productive for specialized crops.

The extensive active sand areas appeared to have had two primary causes. History's testimony concurred with the statements of pioneer settlers that the entire area once was covered with a climax vegetation of lush grasses and mature coastal forests, the grass so tall that it was difficult to tell at any distance whether an approaching man was on foot or horseback. Overgrazing, through overstocking with sheep and cattle, produced localized scour spots that soon developed into cancerous movements inland, destroying other cover and augmenting the flowing sea of sand. Fire and intensified recreational use in later years aggravated the erosion condition and added to the expanding sand dunes.

A more recent cause was found to be the Columbia river jetty, where changing river currents and eddy effects had produced 2,000 feet of seaward deposition since 1856. This active process was too rapid for natural vegetation to keep pace, with the result that a denuded sand spit had been built far out into the ocean and river mouth.

It was found in reconstructing the normal topography on the original Clatsop Plains that the land had built up for several centuries in the form of a series of parallel ridges, extending from the front, or littoral, dune back toward the forest in the lee. Proof of this theory can be seen today on such areas as the Astoria Country Club golf course, where the fairways extend for long distances down the narrow troughs formed by two parallel dunes. This fact was important in planning the control treatment, because of the close relationship between winter and summer winds and the direction of normal dune formation. Most of the littoral dune had been destroyed, and many of the parallel dunes had extensive blowouts and eroded gaps that were coursing sand into inland areas and threatening other mature dunes, as well as already having dammed a river that originally had flowed the length of the plains area into the ocean. Visible evidence of this damming process remains today in the form of a chain of pinched-off, narrow lakes with large sand interstices and also in the form of remaining scattered hummocks of the willow growth that lined the original watercourse.

In considering the ultimate or desirable land use of the Clatsop Plains, it seemed apparent that recreation was the highest use based on soil capabilities, because the soils were too highly erodible to be continually grazed or cropped agriculturally. The ownership pattern already favored such a use, because 40 percent of the land was in federal and state holdings. In addition, most of the private land owners were interested in the stabilization and correct use of the land. Exclusion of livestock grazing was one of the first

and most important steps taken in initiating the control program.

Field work was begun by the Soil Conservation Service in the fall of 1935, with the assistance of a CCC camp, and in the spring of 1936 the Soil Conservation Service established a nursery unit to produce beach and dune grasses and some tree stock, collect seed, and test plants and cultural methods.

Construction of the foredune immediately behind the storm tide line was considered of first priority, to halt the sand out in front and to act as a dike during storms. This work was effected by using picket-type sand fences spaced 30 feet apart and parallel to the beach. Four and one-half foot pickets, four inches wide, were placed about one foot in the sand, with a four-inch spacing between pickets, and their top line even. This spacing permitted the building up of a broad, rounded dune, instead of either a sharp or double crest resulting from other fence spacings. The fence was raised once to increase the height of the foredune, which was then planted to beachgrass. This fence was more than eight miles long and built up the sand deposit about two feet a year.

European beachgrass (Ammophila arenaria) (L) Link) and its planting affords interesting information. This species at first was transported up the coast from Coos Bay, a distance of 250 miles. The grass grows as sand accumulates and thus raises the height of the dune, and is intended to serve the dual function of holding sand, thereby keeping it from scouring, and causing deposition of loose sand blowing in from unstabilized areas. It is a pioneer grass with coarse stem and shallow root and spreads rapidly by underground rootstocks, seldom setting viable seed.

New plantings are more successful if pieces of the original plant are used. Shoots occur in clumps and on their lower end form small buds at the nodes, below ground level. Such buds develop new plants. One shoot with two or three buds at the base is sufficient for a planting stock.

Planting stock can be dug from established field areas or obtained from nurseries. Dug stock is shaken free of sand, dead trash cleansed from the culms, and the clump broken up into small bunches of two or three shoots each. Shoots are tied in bundles of about ten pounds and may be stored for two or three weeks in heel-in beds during cool, moist weather. Each bundle is cut back to an overall length of from 18 to 20 inches, for uniformity in handling and planting.

Planting is done almost entirely by hand. Two men, using a tile or ditching spade, comprise a planting team, one of them making the slit or hole, and the other inserting the shoot to a depth of 12 to 14 inches and closing the slit with heavy heel tamps to eliminate air pockets. Planting hills are spaced 18 inches apart, and three to five shoots per hill are used. This spacing may be increased in protected sites, particularly if commercial fertilizer, such as ammonium sulphate, is applied at a rate of not less than 40 pounds per acre. Fertilizer results in rapid and vigorous growth and should be applied in the spring.

The planting season for this and other grasses generally extends from November 1 to June 15, though some allowances must be made for individual sites, such as winter-submerged flats. Planting costs have varied from $40 to $100 an acre, depending upon site, spacing and other conditions. These figures include transportation, supervision and similar costs. From 600 to 800 pounds of grass stock per acre are needed for a planting spaced 18 inches by 18 inches. A two-man team can plant about 100 pounds of grass a day in average going.

Instead of the picket fence scheme, grass plantings themselves may be used to start formation of the foredune. This is a slower but less costly method. To obtain a well-shaped dune, the windward side generally is planted 18 inches by 18 inches, the dune crest 12 inches by 12 inches, and the leeward side 24

inches by 24 inches, all with five plants to the hill.

With the foredune construction completed, the plantings on the leeward areas were started, in accordance with the master plans for reconstruction of original topographic features. Here, too, it was necessary to begin with primary sand-stilling grasses, following the planting process just described.

Tests were started in cooperation with the Bureau of Plant Industry and the Oregon State Agricultural Experiment Station to determine methods of increasing grass production to meet the heavy requirements of the dune control program. Other grasses were tried. American dunegrass (Elymus mollis Trin.) was planted during the first year but proved unsatisfactory. American beachgrass (Ammophila breviligulata Fernald) proved adapted to many sites, particularly where maintenance was required, because of its habit of spreading by rootstocks. The application of fertilizer was studied in detail.

Some interesting facts were discovered in planting the primary grasses in the lee of the foredune. For instance, it was thought that planting grass in strips with alternating sand areas in between would be a worth-while economy in grass and labor, but it was found that the grass strips did not spread out into the bare sand areas as planned and that in some cases these alternating unstabilized areas even became critical scour spots, sometimes worse than the original dune areas. Then, too, the primary grasses did not make any appreciable growth in areas where the incoming sand had been shut off by the foredune, and it was necessary to make fertilizer applications to obtain the desired grass density. These and similar problems had to be worked out through careful experimentation.

As indicated earlier, experience on other dune projects had shown conclusively that initial stabilization with sand-stilling grasses did not give a sufficient or permanent cover on sand dunes. Secondary vegetation must be introduced to obtain permanent fixation, for the primary beach grasses will decrease in vigor and growth once the sand stops coming in to stimulate their growth.

On the Clatsop Plains area, this secondary stage of control employs either herbaceous or woody plants. The determination of the respective control type is governed by numerous factors, including the future recommended land use, the severity of the site, the topography, and similar conditions.

Secondary and permanent grass-legume mixtures are seeded on the areas that are determined not suited for woody vegetation, and in many instances in wooded areas to speed up the provision of effective cover. A requisite of secondary vegetation in the dune program is that it supply nitrogen to the site to prepare it for subsequent successions of herbaceous or woody species.

Native species of grasses and legumes collected primarily from the dune area have been used to date for secondary seedings in beachgrass plantings. Seashore bluegrass (Poa macrantha Vasey) and seashore lupine (Lupinus littoralis Dougl.) usually are seeded in mixtures not later than two years after initial beachgrass plantings are made. These two species are able to withstand considerable sand accumulation during the early period of their life cycle and prepare the site for the more permanent purple beachpea (Lathyrus maritimus (L) Bigelow) and native red fescue (Festuca rubra L. var. californica), which usually are seeded one year after the bluegrass and lupine and at about the same time as the climax clover and bent grasses.

These grasses usually are drilled, in the fall, unless sufficient mulch has been accumulated in the beachgrass planting to afford good protection for broadcast seed. Broadcast seeding is effective only when a good mulch is present. Such seeding rates are used as will produce 125 pure live seeds of the total mixture per square foot.

Sod formed of the grass species mentioned and the few additional woody

plants prevalent on the dunes gives an erosion-resisting vegetal cover capable of withstanding only limited usage. Normal pasturage and intensified recreational use cannot be practiced, because the soil type prevents the formation of a firm sod that will withstand heavy trampling. The placement of additional woody plantings, therefore, seemed highly desirable and even necessary.

Almost without exception, woody plantings made to date occupy the rougher and more irregular topography where the major use unquestionably will be recreation. Protective belt plantings of woody species also are being placed along critical edges and on sites where it is necessary to provide special protection for roads, buildings, structures and existing vegetation. Such belt plantings sometimes are planned to form an interlacing network of live vegetation that effectively lifts the winter winds from the sands' surface and deflects and dissipates their scouring blasts.

Where originally it was thought that grazing might still be carried on successfully on the plains area, and hence woody growth would be undesirable because of its unpalatability and its physical obstruction to such grazing use, the fact is becoming more apparent, even to land owners, that good and permanent land use must preclude grazing, and hence that woody plantings will help to obtain the conversion of land use from grazing to recreation by providing a type of cover affording little or no grazing value. Originally, too, the adaptability of woody species on frontal dune and plain areas was not known fully enough to warrant recommending any proved planting schemes and mixtures, but the success obtained in recent years with woody plantings virtually has eliminated this technical doubt.

Secondary woody plantings are introduced at about the same time as the mixture of pea and fescue is seeded. They can be established successfully on more protected sites in one-year-old beachgrass plantings, but in the more severe sites a two-year-old grass stand is preferable. Based on results obtained to date from many experiments, they do not require the protection of secondary grass and legume seedings, although the latter help.

The more extensive secondary woody plantings on the Warrenton dune area to date have been placed to the rear of the plains and parallel to the ocean, with the plan in mind that they will be advanced toward the frontal dunes as the sites become more favorable, through beachgrass and grass-legume successions. Another influencing factor in determining this placement was the necessity of protecting partly-eroded back dunes with numerous wind gaps and blowouts likely to create sources of sand for inland deposition. Then, too, the buildings of Camp Clatsop, Oregon National Guard Camp now in defense use, required immediate protection, and woody plants afforded the wind buffer required.

In advancing the woody succession toward frontal dune areas, it must be remembered that the original climax cover in front never had been, except in scattered spots, the sitka spruce-western hemlock association found farther inland, and therefore the introduction of this climax was at first questioned ecologically. A careful edging out with experimental plantings, however, even as far as the extreme foredune, has demonstrated that such a program will be feasible, with minor exceptions.

On the back areas, a scheme of "stripping" or "gridironing" has been used so far in the placement of secondary woody species. The closely spaced broad bands were intended to provide maximum protection to the maximum area with the minimum use of labor and plants. The typical plan has been to place a ten- to fifteen-row, and sometimes a thirty-row, band several hundred feet in front of the area to be protected and parallel to the ocean. The spacing used was 18 inches in the row and two feet between rows. A fifteen-

row band thus would provide approximately a 50- to 60-foot width of vegetated buffer strip.

Back of this front band, other parallel bands were planted, about 100 feet apart and of about the same width as the first band, until the stabilized vegetation in the rear was reached. In addition, narrower bands of from 6 to 10 rows each were placed at right angles to these long main bands, intersecting them at about 60-foot intervals. The pattern thus was a series of rectangles formed by the planted bands.

The species found most successful in withstanding the severe site conditions has been Scotch broom (Cytisus scoparius (L.) Link), which is held in disrespect by most coast farmers but draws gasps of delight from tourists and artists when, for the first time, they see its mass of golden blooms in the early spring, blanketing whole hillsides, and blotching encroached pastures and cutover timberlands.

The plant is considered intolerant and tends to disappear in a mature forest where shade inhibits its growth. Its use in the planting program is as a nurse crop or plant, to prepare the site for pines and other conifers, by supplying nitrogen to the site in which it grows, and its evergreen habit is a decided asset in protecting vulnerable sand areas from winter scouring.

In planting this and other species, a two-man crew has been used as the unit of organization. One man, using a tile spade, digs about a ten- to twelve-inch hole, depending upon the root size of the plant; the second man then holds the nursery plant against the vertical back at the plant's root collar line until the first man has refilled the hole with wet sand and tamped down the sand with his heels to provide a firm site. The second man generally carries the plants in a bucket, which has been found more satisfactory than a planting tray, because of the greater wind dessication to plants in the latter. Such a crew can plant about 400 to 500 plants per CCC man-day, or about 800 to 1,000 for the team. The 1-0 nursery stock, cut back to a ten-inch top, is used for most Scotch broom plantings. Seeding has been tried, but the results have not been too satisfactory.

The growth attained by the broom in one season is remarkable. Recent measurements taken on plantings made in January, 1941, indicate that many plants have made as much as five feet of height growth, with a three-foot growth the general average. The recuperative powers and tenacity of the species on the most adverse sites is amazing; in one instance, an extensive planting of broom in a bad wind gap had been marked for replanting this spring, but a re-examination at planting time showed that virtually all the plants were stooling out new growth through the sand, and they made such remarkable recovery by fall of this year that no maintenance will be necessary.

On another site, where an experimental broom band had been placed on the front edge of the foredune, immediately exposed to the ocean storms and generally regarded as a hopeless site, the plants, after two years, have established themselves firmly and have a high survival. The band today shows up as a distinct green strip, and subsequent growth probably will be more rapid.

Five- and six-year-old plantings of broom bands have formed dense and almost impenetrable hedges, which afford winter storm cover for Columbian blacktail deer and small game. Such plantings have attained a height of ten to twelve feet. It is interesting to note that the bands have made almost no natural seeding in the rectangles between them, as had been expected, and that additional planting therefore will be necessary to introduce the nurse plant more uniformly throughout the dune area. This fact has changed the future planting plans for secondary woody species in that the bands will be used less extensively in the gridiron pattern, and that instead the species will be planted on a uniform spacing, probably 6 feet by 6 feet, throughout the

entire area to be treated, with one fifteen-row band on the frontal edge to protect the body of the planting from sand deposits and wind. This scheme will provide uniform distribution of nitrogen throughout the fields and will result in greater area coverage.

Another secondary species that has been used less extensively to date, but which promises to be a valuable plant, is tree lupine (Lupinus arboreus Sims), also an evergreen legume and nitrogen fixer. This species has been found very successful in New Zealand dune work. Its growth habit is spreading, and its annual deposit of litter is of benefit to the sand. Although the plant is slower in getting started, it makes a very rapid later growth, and soon closes in to form a dense mass. The planting can be done only through spot seeding, and inoculation is necessary. Generally, about two seeds per hole are planted, and either a corn planter or metal probe can be used in placing the seed about two inches below the surface. It is intended to use this species more in future work, but until now no large-scale plantings on frontal dune areas have been established for observing its resistance to storms and its growth rates.

The introduction of trees is the last step in the woody planting program, and corresponds to the seeding of climax clovers and bent grasses. Generally, conifers, which provide year-round cover, can be planted one year after the broom or tree lupine, and sometimes the same year, if the site is favorable. The conifers thus follow the shrub plantings in advancing toward frontal dune edges, but it is not probable that they will extend as far oceanward as the shrub plantings, which have less height to expose to the wind. It is not expected that the conifers ever will attain full tree height or commercial development, for the ravages of storms will tend to keep them shorter-boled and more gnarled. They will reach a height sufficient to aid in deflecting winds, however, and will help in binding the sands.

A 6-foot by 6-foot spacing commonly is used in placing the conifers, and pines have been used most frequently and seem better adapted than the Sitka spruce (Picea sitchensis (Bongard) Carriere), which does better on more protected sites. Originally, it was the plan to fill in the rectangles formed by broom bands with block plantings of pines, and this has been done to a large extent. It has been found so far, though, that such plantings are not ideal, because the pines in the center of the rectangles lack the nitrogen required for better growth, and soon assume a yellowish appearance, although they survive quite well. In contrast to the performance of their more vigorous neighbors growing in proximity to broom bands, their growth is far inferior. Sometimes pine plantings have been made in stands of beachgrass without introduction of the secondary woody legumes, and here the same yellowish foliage results, showing the need of the nitrogen fixer. This shows definite need for following the sequence of beach grasses, secondary woody legumes or herbaceous legumes, and finally conifers, if the best success is to be obtained.

Many species of pines have been tried, but the native shore pine (Pinus contorta Loudon) has proved the more adapted and will be used almost entirely in future tree plantings. The 2-0 stock is used for all species. Other pines planted have been Scots pine (Pinus sylvestris L.), Austrian pine (Pinus nigra Arnold), mountain pine (Pinus pungens Lambert), cluster pine (Pinus Pinaster Ait), pitch pine (Pinus rigida Miller), and jack pine (Pinus banksiana Lambert). Some of these, such as the Scots pine and cluster pine, have proved good but not superior to the shore pine. It is a distinct saving in nursery operations and field work to standardize on one species, and shore pine seems the logical selection.

Pines, too, have made exceptional growth, particularly during the past growing season. Ordinarily, it requires several years for the plants to become established, and height growth gen-

erally is not made until then. Five- and six-year-old plantings in more protected sites show a lusty, vigorous growth—as much as 30 inches this year —and even some of this spring's plantings have put on one-foot leaders. Established plantings, such as those on the Hamomnd Beach area on the north end of the project, now are in a position to make good growth annually, and stabilization of such areas is a reality, provided adequate protection from grazing and other misuse is assured. Probably in the distant future the climax species of Sitka spruce and western hemlock (Tsuga heterophylla (Raf.) Sarg.) will invade areas such as Hammond, and complete the ecological sequence.

Some native evergreen understory plants have been used in more mature plantings, but their place so far is limited by the immaturity of the pine stands. Evergreen huckleberry (Vaccinium ovatum Pursh.) and kinnikinnick (Arctostaphylos uva-ursi L. Spreng.) seem best adapted for this use.

Minor use is being made of other species. Along lake edges and in low flat and wet areas, Hooker's coast willow (Salix hookeriana Barr.) and the Oregon crabapple (Malus fusca (Raf.) Schn.) have been planted with success. The nutka rose (Rosa nutkana Presl.) has been utilized in protected sites to provide wildlife food and cover. Other species scattered in smaller plantings are red alder (Alnus rubra Bong.), poplar (Populus spp.), black locust (Robinia pseudoacacia L.) and salal (Gaultheria shallon Pursh.). The limiting factor in using these species is the average site severity, which exceeds the tolerance of the plants named, and the inadequate winter protection provided by the deciduous species.

Among recent developments in dune-control techniques is a mechanical transplanter which, for grass plantings, reduces the planting time per acre from 80 man-hours to 18 man-hours for an 18-inch by 18-inch spacing. A three-row planter requires seven men for operation, and can be drawn by a tractor. The transplanter also is adapted for tree planting and may prove useful where large labor quotas are not available.

The year 1941 sees most of the initial plantings and construction of the littoral dune completed. Many secondary plantings of herbaceous and woody species have been made, but at least half of the area still requires the planting of secondary woody species, and more than half requires the final tree plantings. The plantings made to date total almost 2,000,000 plants, but there still is need for well over 1,000,000 plants. The future of the work is assured by the recent formation of a soil conservation district by the local landowners. This will provide for the protection and maintenance of completed work.

With the reduction in CCC labor quotas, it is difficult to predict how much field work can be accomplished during the next several years. A big job remains to be done, and the full efforts of the land owners, the Soil Conservation Service, and other agencies will be needed to gain the objective of a stabilized Clatsop Plains for posterity to enjoy.

RESULTS AND TRENDS AT THE NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

H. T. Gisborne*

Even a superficial examination of the work and results obtained by research at the Northern Rocky Mountain Forest and Range Experiment Station brings out one striking fact. Forestry and the resarch needed to improve the practice of forestry have expanded far beyond the former and still too common concept that forestry is merely the growing and harvesting of trees as commercial products. Because of this, forest research is no longer a field for the pure dendrologist, silviculturist, biologist, nor even for the more complex economic-biologist alone. It is rapidly becoming a specialized form of land management aimed at several diverse products including lumber, beef, leather, mutton, wool, venison, fish, water, clean air, cheery campfires, and beautiful vistas. The character of our research has changed and it must change still more to meet this new and much larger concept.

Silviculture.

America inherited or transplanted its original science of forestry from Europe. Our early ideas of forestry came from several European countries which were so densely settled and so poorly supplied with transportation that the growing and harvesting of heavy bulky timber products was an essential measure for an adequate local and national life. Silviculture to produce the biggest possible volume of the most desired species of trees was therefore the essence of forestry when we began our practice. It was consequently natural that silvicultural research became the first and the major line of work pursued for many years by the Research Division of the U. S. Forest Service, particularly the forest experiment stations.

When the Priest River Experiment Station was established in 1911 it was likewise logical that the first, limited research should be located in and largely confined to the most valuable tree species in the entire northern Rocky Mountain region, the white pine of northern Idaho. As you all know, many publications were issued from time to time reporting the results of the various phases of this work. Technical bulletin No. 767, issued in May, 1941, summarizes the results of all of this so that the timber land owner of today, whether Federal or state agency, or private individual or corporation, now has available a clear and complete picture of all the major biological factors involved. This bulletin is one of the few complete treatises on the silvicultural management of an American forest type. It is, undoubtedly, THE outstanding contribution of our experiment station during the past several years.

Another research, now nearing completion, will furnish timber land owners with still additional information on growth conditions during early stand development of both white pine and its common associates. This is of particular value in predicting the future crops from cutover areas and determining which areas will, by their stand composition, justify blister rust control labor and expense.

Less far advanced, but equally essential to the future economic practice of tree culture, is a study of light cuttings intended to harvest those trees most likely to die from suppression, insects, etc., before the final cut is made at maturity. Assistance from the Forest Insects Laboratory at Coeur d'Alene and the Forest Pathology department of the University of Idaho has greatly extended the applicability of this research.

In all of these silvucultural studies the major emphasis has been on white pine, the most valuable single species. This is as it should be when efforts must be restricted by funds inadequate to cover all species. When viewed from the newer, wider standpoint of the forest as a whole, constituting a resource

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* Read before the Forestry Section of the Northwest Scientific Association in Spokane, Washington, December 30, 1941.

of much more value than for sawlogs and commercial timber alone, it is clearly evident, however, that the silvicultural research program of our experiment station is grossly inadequate. Work on the other species, ponderosa pine, Douglas-fir, cedar, larch, spruce, the true firs, and our extensive stands of hemlock, does not compare to that devoted to white pine, yet, as a matter of fact, these species, not white pine, constitute the bulk of the forest growth in our region.

These other species have not been entirely neglected, however, because research aimed at restoring forest growth to lands devastated by fire or by bad logging and brush disposal practices has included several species besides white pine. In fact, one most recent contribution to forestry and the economic future of our region has been the development by Wellner and Schopmeyer of successful methods of artificial regeneration of several species by direct seeding instead of planting. Not only white pine but ponderosa pine, Douglas-fir, spruce, and cedar have been used experimentally in this attempt to obviate the labor and expense of nursery production of seedlings for planting on devastated areas. Real success has been obtained with every species on certain sites. With the completion of work now under way it will be shown that properly selected areas can be reforested successfully without recourse to the laborious practice of hand planting nursery-raised seedlings. On the other hand, certain other areas or sites are still believed to be best reforested by hand planting, regardless of the species used.

As a contribution toward better methods of stand improvement by relief labor, including the post-war labor that is certain to be expended on our forest lands, the Northern Rocky Mountain Station prepared a manual several years ago. More recent tests by the station and by several national forests have provided additional data to guide such work after the war. We are still lacking, however, a sufficiently complete manual to guide relief labor which may be available for disposing of slash, snags, and windfalls which make fire control so difficult on many areas. Such guidance is necessary to aid fire protection both on roadside strips and on large areas of single burn which cannot be guaranteed adequate fire control until the snag menace is reduced.

As is evident, nearly all of the silvicultural research done so far by our station has been controlled by the dollar value of the product. I believe it is correct to say that nothing has yet been done to study our forests as a fundamentally biological resource from which many benefits, in addition to sawlogs, can and must be obtained in the longtime plan to make our region both self supporting and a real contributor to the national welfare. Silvicultural research to reconcile the contrasting demands of logging and recreation, of lumber and livestock production, of trees versus brush for water control, and of trees versus brush for wildlife production, is still conspicuously absent from our program. Yet these are the truly basic problems ahead of us if we are to practice silviculture for anything more than sawlogs.

I predict that the future trend of our silviculture research will be more toward these other aspects and less toward commercial sawlogs as soon as the public becomes fully and clearly aware of the fact that forestry is and should be far more than the mere growing and harvesting of trees.

Products and Utilization.

The waste inherent in normal American methods of logging and manufacturing lumber was clearly appreciated by the pioneer foresters of America. They needed no precedent from Europe to convince them that research applied to methods of harvesting and utilizing forest products could produce benefits fully equal to any silvicultural method that might increase the growth rate or the quality of timber. It is a matter of historical record that here in the northern Rocky Mountain region the Forest Service commenced active investigation of forest products and utilization methods two years before they initiated any work in silviculture, ten years before we began research in fire protection, and twenty years before range manage-

ment research was undertaken by the experiment station.

During its 32 years of service within the northern Rocky Mountain region, the main objectives of the Division of Forest Products and Utilization have been to provide all federal agencies administering forest lands, the state forest departments, the lumber industry, and the private forest land owner with accurate and up-to-date information on several features of the timber product: (1) the quality and properties of each kind of wood, (2) the current demand for each, (3) the efficient utilization of each, (4) the best and most practical methods of logging and lumbering, and (5) the value, costs of producing, and the amounts produced of the many kinds of forest products cut within this region.

The information obtained by this work has found immediate and valuable use in appraising the value of standing timber, establishing better utilization standards, indicating the best and most efficient methods of logging and milling, recommending the best and proper use of wood products in service, cutting down wood waste, and revealing new forms of use of our particular forest products.

Forest Products and Utilization research at this station has been conducted under three main lines of study: (1) Timber Harvesting and Conversion Studies; (2) Wood Preservation Investigations; and (3) Forest Statistics. In both (1) and (2) the Division of Forest Products consults the silviculturists, the entomologists, and the pathologists so that no promising avenues or information are overlooked.

Under Timber Harvesting and Conversion have been included logging output studies in sawing, bucking at the landing, horse skidding, tractor-arch and donkey-engine skidding, truck loading, hauling and unloading, power sawing, etc. These studies to determine better logging practices have been based on the cutting of 25 million feet of timber. Also included are the financial aspects of logging and milling studies which supply important information on (1) the quantity, grade, and value of the lumber or other forest products produced by trees of different species, sizes, and grades; (2) the cost of producing the forest product; and (3) the size and grade of tree and log which it is profitable to utilize. The data obtained consist of detailed and accurate records from wood stump to shipping shed of 874 ponderosa pine trees, 720 western larch and Douglas-fir trees cut for ties, and 1,106 western white pine trees. The products studied have included lumber, ties, and match plank.

Utilization studies in the sawmill and in the woods are also included under Timber Harvesting and Conversion studies. The purpose of such studies is varied. From them we have learned much about overrun, grades of lumber produced by logs and trees of different species and types, the efficiency of various sawmill machinery, the waste occurring in sawing, the cost of sawing different products, the residual wood left after logging, and the Christmas tree and white pine match industries.

The little-used species such as white fir, hemlock, larch, Douglas-fir, spruce, and lodgepole pine are also being studied to assemble information on the available supply, quantity, technical properties and use. Much more effort has been devoted to the utilization of these secondary species than to their silvicultural management.

The objectives of the second major line of studies, Wood Preservation, are to determine (1) the durability of treated and untreated telephone poles, fenceposts, ties, and other rough timber products obtained from species native to the northern Rocky Mountain region; and (2) the comparative value of various wood preservatives and treating processes. We now have service records on more than 31,000 telephone and power line poles, on 1,000 stubs used in reinforcing poles, on 11,000 fenceposts, on 6,000 railway ties, and for 184 mining timbers. These records show conclusively that it pays to treat timber which is exposed to decay-favoring conditions. Not many years ago, the average life of a fencepost in service was from 5 to 10 years because it was not treated at all or was treated by inadequate methods. Today the life expectancy of a

similar post can be raised to 20 years or more by proper preservative treatment.

Forest Statistics, the third major line of study by the division, include up-to-date records on stumpage values, lumber production costs, the selling value of the products, and the amount of those products yielded each year within the region. The stumpage value for each of the various species within the region have been compiled each year since 1912. The cost of producing lumber by the sawmills of this region have been obtained each year since 1916. The wholesale selling price of lumber has been compiled by species, grades, and sizes each quarter since 1916. Data showing lumber production from 1869 to date have been collected and compiled by species and geographic subdivisions. We also know where that lumber goes throughout the United States, although that assembly of information is done for us by our Washington Office, using data obtained by the Bureau of the Census.

Though work in Forest Products and Utilization Research will continue along the three major lines just discussed, studies to assemble information on the available supply, quality, technical properties, and new uses of the secondary species within the region are likely to be stressed more in the future than they have been in the past. During the past few years some information has been acquired on the possibilities of wood pulp production in the region, the use of western larch for plywood, the building up by gluing of larger dimensioned timbers of fir and larch, and better sawing and utilization practices for a number of the so-called "little-used species." To round out our regional forest economy we must make these the species of many uses.

Range.

When research in range management or livestock forage was added to the program of the Northern Rocky Mountain Experiment Station and the name changed to Forest and Range Experiment Station in 1932, many people thought that this was extending and perhaps stretching the field of forestry. Actually it was not, because long before the tree growers even entered the field of wild land use, herdsmen and livestock tenders were managing the grazing in the openings scattered through the forest. As Fernow pointed out 40 years ago in his "History of Forestry," game wardens and wildlifers were really the first foresters, and the "forestarii" of the eleventh century were in fact the first forest rangers appointed to guard and manage wild lands. Next came the herdsmen utilizing the forage crop, and, last of all, not until 500 years later, did the silviculturists begin to concentrate their attention on the trees and gradually usurp the title of "forester."

Range management, as one form of forestry, is therefore actually far older than silviculture, and if we in the United States did not have such extensive prairies covered with grass and almost completely lacking tree growth, we would not be so reluctant to grant to range managers their prior and equal right to the title of forester or wild land manager. Likewise, if we viewed forestry in this historical light, we would not distinguish our forest experiment stations as forest and range stations, because the forest in its true historical sense is not composed of trees alone, much less commercial trees alone. The forest is now, and always has been, a trinity of brush and grass and trees. Forestry is the art of managing all three of these wild land resources without expensive cultivation of the soil that grows them.

Range research at the Northern Rocky Mountain Station has been centralized under two lines or projects. First, to find better ways to manage range lands that make up at least 70 million acres of the total area in Montana and north Idaho. Second, to find best species and mixtures and the most effective methods for rehabilitation of the forage cover on several million acres of range land that have been depleted by plowing or otherwise. In both cases the work is aided by excellent cooperation from the Bureau of Animal and Plant Industry and from the Montana Agricultural Experiment Station.

That heavy grazing means lower net

production costs for range cattle than a more conservative degree of range use has long been the accepted belief and policy of many western range livestock producers. Results from a range management experiment with three breeding herds of cows conducted near Miles City, Montana, since 1932 have clearly demonstrated that this belief is erroneous and a costly fallacy for typical short-grass ranges. When range was grazed moderately for seven years, cows have produced an average of 63.9 pounds more weaning calf weight than the average from cows on adjacent range pastures that were grazed more heavily. When range was grazed lightly, the gain in weaning calf weight averaged 47.1 pounds more than under concentrated, heavy grazing. Furthermore, the lower weight on heavily grazed range actually costs 28 to 44 percent more for forage plus supplemental feed. Specific figures like these are quickly grasped by the stockmen, who thereby are enabled to make more money both currently and in the long run.

But "long run" grazing has another natural condition with which it must contend. The Northern Great Plains apparently has suffered from severe drought years at irregular intervals since time began. On the average, these droughts may be expected every 5 or 6 years, according to our available weather records. The most disastrous drought period of record was in 1934 to 1936, and as a result of it the density of short-grass range vegetation was reduced to the astounding and dangerous condition of only 10 percent of the 1933 level. Millions of range sheep and cattle were forced off the range and onto the market at sacrifice prices. This forced liquidation was found to have been much more severe on heavily stocked than on more conservatively grazed ranges. The experiment to test the effects of heavy, moderate, and light grazing practices therefore has demonstrated that a conservative rate of cattle grazing is decidedly the most practicable and effective means of keeping production costs low and minimizing losses and risks during those drought emergencies, which seem inevitable in our region. Already a gratifying change toward a more conservative grazing range management is evident as a result of this recent research demonstration. A widespread change in practice would clearly result in greater stability of social and economic conditions for the entire Northern Great Plains.

For those lands previously ruined or still being ruined by overgrazing, and for those lands laid bare by misguided attempts to plow and cultivate, there is an obvious need for determining the best methods of getting them back into grass. Under a limited program of range reseeding research, rough guides have been developed as to what, where, when, and how reseeding should be done under varied conditions in Montana. It has been demonstrated that crested wheatgrass and a few other species may be successfully reseeded under a wide range of soil and site conditions at a reasonable cost. These rough guides are being refined, additional species and mixtures tested, and best methods worked out for the establishment of those that pass preliminary tests. During the past 5 years, land owners and managers have reseeded nearly half a million acres of depleted range land in Montana, in which information and guides already developed have been widely and successfully used. Breeding of adapted range plants is a promising field that has as yet received decidedly inadequate attention.

At present, research in range management is in a phase common to nearly all scientific investigation. We see our problems but we realize that there are many different ways of attempting to solve them. Some methods will obviously be more productive and less expensive than others. Some methods cannot be used until certain instruments can be invented. As B. E. Livingston stated the case for the plant ecologists several years ago, "Just what to measure must depend, to a considerable extent and for a long time to come, on what we are able to measure." This need for improvements in methodology is clearly recognized in range research today, and our future understanding of many of the complex ecological rela-

tionships existing, where several important plants and animals must be maintained on the same area, is now being retarded by lack of satisfactory methods of measuring these conditions. One immediate trend in range research is therefore likely to be toward concentration on methodology, much as Livingston and Clements concentrated on this phase for many years.

Fire.

Fire control and fire research are, without doubt, America's most distinctive contribution to the art and science of forestry. Climate, dense population, and intensive utilization of all debris in the forests of Europe seem to have combined to minimize the fire problem there. A different climate, sparse population, and our inability to use all the dead trees in our American forests combine here to produce a condition greatly different from that in Europe. Consequently, our condition was not at all appreciated by the pioneers of American forestry. In fact, Fernow barely mentioned the fire problem in his early summaries of the American forestry situation. Yet today fire research is included in the programs of 6 of our 12 forest experiment stations.

As most of you know, the Northern Rocky Mountain Station was the first in the United States to assign one man full time to fire research. Previous work in California, Oregon, Washington, and our own region, had been on a part-time, exploratory basis. You are all familiar also with the major contributions we have made: (1) The measurement of fire danger on a numerical scale, and (2) the systematic planning of fire control facilities and man power according to the fuel types, occurrence rate, values at stake, and currently measured fire danger.

The purpose of both of these projects is to provide the obviously needed methods, instead of personal opinion, for obtaining adequate fire control at least possible cost. With a resource of such value as our forest timber, forage, wildlife, and recreation, each so completely destructible by fire, and with watershed values so greatly affected by fire, it was evident after the 1910 and 1919 Idaho fires that total dependence should no longer be placed upon personal opinion of the facilities and man power needed to protect these resources. Personal opinion by rangers, supervisors, and others had been the sole basis for protection action in the early years, and was in fact up until about 1930 to 1935. While that opinion often was excellent, and while many of the failures in fire control were definitely due to lack of sufficient facilities and funds, still it was and is apparent that a resource of such extent and value as our forest deserves systematized protection with human weaknesses, prejudices, and errors reduced to the minimum. Fire research has therefore been aimed at methods which, by systematic application, would reduce human errors of judgment and thereby attain better fire control at less cost.

Judging the degree of existant fire danger was, of course, one of the most prevalent early sources of error. The instrumental measurement of fire danger was therefore aimed at this weakness. For several years now we have had a system of measuring fire danger and it has been in use, as you know, on all 10 western Montana and northern Idaho national forests, in Glacier and Yellowstone National Parks, and on several Indian Reservations. During the past year our knowledge of when and where to measure fire danger has been greatly improved by publication of U. S. Department of Agriculture circular No. 591, "Influence of Altitude and Aspect on Daily Variations in Factors of Forest Fire Danger" by G. Lloyd Hayes. Within the next few months we expect to improve our methods still more by issuance of a new fire danger meter. This will be model 6 in the series of danger meters produced by our station since 1931.

As most of you know, our station has not done any work in fire control planning since 1936 when our funds were reduced and Lloyd Hornby was transferred to the national phases of this project. Progress has been made, however, in both the actual application of Hornby's principles and in their development. Regional Forester E. W. Kelley, Fire Chief Axel Lindh and three of his assistants, Clarence Sutliff, Clayton

Crocker, and Ralph Hand have contributed greatly to this work during the past several years. It is now planned to bring Hornby's famous "Progress Report" up to date, probably next winter, by incorporating the new knowledge acquired during the past five years. This is planned as a joint project by the regional division of fire control and the experiment station.

There is another field for fire research toward which I am convinced we should swing more and more of our effort. This is the field of the economics of fire control. As I stated, in opening this paper, the objectives of both forestry and fire control used to be limited and largely to commercial timber, sawlogs, dollars of revenue. Attainment of these objectives therefore naturally dictated the extent and degree of fire control. But these objectives have changed, for within the past 10 or 15 years a marked development has occurred. The people of our country, and particularly in our region, have discovered that the national forests, the state forests, and even private forests, are now accessible to their use for hunting, fishing, camping, and just a Sunday drive out through the cool, green woods. These people, by the tens of thousands, are beginning really to use the forests, and by that use they are showing clearly that forestry must do much more than produce sawlogs and that fire control must do much more than merely protect commercial timber values alone.

The automobile dealer, the filling station operator, the sporting goods dealer, the restaurants and hamburger joints along the road, are affected by this change. Even the airlines are beginning to bring hunting parties from the East out West. And the local owners of 5- and 10-place ships are picking up a little increased business, taking these parties into our wilderness area landing fields. Even the railway express company is affected, for on November 20, 1941, the express shipment of wild game reached a total of nearly one ton in one day from just one town in this region. That was such good news to express company officials that they gave it out to the newspapers. That should be good news to us, for it is evidence that we have something besides sawlogs and commercial timber which the people want. The people are telling us so in no unmistakable terms and we foresters would do well to do more than just listen.

There is one additional research aspect to this new development. We have, in the past, concentrated considerable research attention on fire damage studies. It is well now to begin to remember that under certain conditions, for certain purposes, on certain areas, fire may produce benefits as well as damages. Usually this depends on the social or economic purpose of management of the particular area. Where the tree growth is entirely noncommercial, but wildlife is the principal social or economic product desired, fire undoubtedly can be used to do more good than harm. Likewise, where overdense and therefore stunted lodgepole occupies good white pine or ponderosa pine sites, it is possible that fire followed by planting can do more good than harm. If we will investigate these local objectives with a willingness to face facts, and a refusal to be bound by old axioms such as "you can't herd fire" we should be able not only to reach our objectives sooner but also to reduce the cost of fire control. These are some of the reasons why I contend that the future trend of fire research in this region is likely to give much more emphasis to both the social and the economic objectives of forestry.

Forest Survey.

The objective of the forest survey is to find out how much timber the nation has, how fast it is growing, how fast it is being used, and to interpret these findings as an aid in the formulation of private and public policies for the most effective and rational use of land suitable for forest production. This work is well along in the Pacific Northwest, the Deep South, the Appalachian region, the Lake States, and the northern Rocky Mountain region.

In our own region work was started in 1932 and has been completed on the 32 million acres of the Inland Empire comprising northeastern Washington, northern Idaho, and Montana west of

the Continental Divide. Only a bare start has been made east of the Divide. The field work involves systematic examination on the ground of the land area, section by section. A 2-inch-to-the-mile map is made, showing the forest cover by species, age, and other classifications, and showing grassland, improved farm land, roads, streams, etc. For the forested areas, timber volume estimates are made. Wherever the owner is willing to make his own records available to us they are used as a base. Otherwise, the field man determines the volume by ocular estimate or by establishing sample plots and measuring the merchantable trees.

In the office the forest area and volume figures are compiled for townships and counties by kind of owners and other classifications. As one of the very important end results of the survey, these data are summarized into tables. The average annual timber volume growth information in these tables is obtained from special growth studies. The current annual timber cut is calculated by means of Bureau of the Census figures. Special studies are made of fuelwood, fenceposts, and other items. A second end result of the survey is a reduction to a 1-inch-to-the-mile scale of the maps previously mentioned and a combination of these into sizes for most convenient use. The third principal end result is a report interpreting these findings and suggesting action designed to improve the situation.

Regional and local planning agencies are important users of these survey reports. Planning agencies, states, counties, and railroads use these maps. The reports are designed to acquaint all interested local people with their own forest situation. In Idaho several hundred copies of report dealing with northern Idaho situation have been supplied to schools for class instruction purposes.

As previously stated, and as must be obvious, this survey or inventory is primarily aimed at commercial timber. It is not a forest survey in the sense that forests and forestry involve far more than sawlogs. While the survey will do what it was originally intended to do—give all land-use planning agencies adequate data concerning commercial products such as sawlogs, match stock, pulp, etc.—still it does not pretend to include all of the many other forest values which have recently begun to assume such high social and economic significance. Hence, I predict that the trend in this work is going to be the same as the trend in fire control and fire research—future work will shift the emphasis more and more toward these other forest values which, just like timebr, are growing here, being depleted there, and by such changes producing a market benefit or loss to the local community and to our Nation.

Summary and Conclusion.

Research by the Northern Rocky Mountain Forest and Range Experiment Station is still, to a large degree, confined to the dollar-and-cents phases of forestry. In Silviculture nearly all the emphasis is on the one commercially most valuable species, white pine, even though the bulk of our forest area is producing other species. In Products and Utilization, while white pine dominates the field, considerable effort and real progress has been made with the other species. In Range Research the work approaches the more fundamental biological conditions involved, with perpetuation of the forage crop as the prime objective. In Fire, the goal is still to hold down commercial timber costs and losses with altogether too little attention to purely social losses, and with far too little appreciation of possible benefits on certain areas for certain social and socio-economic purposes. Likewise, the Forest Survey is definitely dominated by sawlogs,, white pine, and the dollar sign.

While Forestry can never be completely divorced from the dollar sign, immediate profit or even distant future dividends in dollars are not the complete and the ultimate controls. Forestry has much to offer that cannot be measured in dollars, yet can be readily evidenced by public demand. It is my contention that the trend of our research is going to be greatly influenced and ultimately controlled by this new and still expanding concept. Protection and production of more and more of each of our forest benefits, not merely those which we can cut, haul out and sell for dollars, seems to be the only sound basis for planning our future research program. The resource itself is the thing. We must know how to protect and produce more of each of our many forest resources.

WASHINGTON FOREST PRODUCTS COOPERATIVE

M. C. James*

President, Washington Forest Products Cooperative Association

For a considerable time it has been difficult or impossible for the average farmer in the Pacific Northwest with small timber holdings to market those forest products which from time to time should be marketed. When these products have been sold, it has been necessary to sell them on a stumpage basis. This method of disposing of many forest products is usually very unsatisfactory from the standpoint of the farmer.

How different, however, has the marketing situation been in this region with other farm products, such as eggs, poultry, and milk products, which have been sold through cooperative marketing organizations. In no other farming region in the United States are the farmers more cooperative-minded or profiting more from this method of selling the products of their farms.

While I was preparing this paper the Washington Poultry and Egg truck was at the back door on its weekly visit to deliver more than a ton of grain for cows, hogs and chickens, and pick up the week's production of eggs, which will command 7 to 9 cents per dozen more in the New York markets than nearby eggs produced in that State. The Snohomish County milk truck had already made its daily visit to the farm to pick up the day's milk.

It is no mystery, then, that the farmers in this section should turn to this same method of marketing their forest products when it was suggested to them by the Soil Conservation Service, after several months' work by their foresters in the farm woodlands of the county.

After several preliminary meetings of farmers owning timber in Snohomish County had been called by the County Agricultural Agent and the Soil Conservation Service, an organization committee was appointed. Several meetings were held by this committee, who, with the able assistance of the County Agent, drew up proposed By-Laws, a Marketing Agreement, and Incorporation papers.

On April 11, 1940, a meeting was called of those interested, at which time the organization papers were adopted, six directors were elected, and the baby farmers cooperative of the West Coast was born, known as the Washington Forest Products Cooperative Association.

Some of the objectives of this association, as stated in the Articles of Incorporation, are:

1. "To engage in any activity in connection with the marketing, selling, harvesting, preserving, storing, handling, or utilizing of any forest products of its members."

2. "To improve the yield of forest land and increase the income derived therefrom."

3. "To establish a conservative cutting policy in the interests of a perpetual crop."

When the organization work was completed, considerable time and energy was expended in making contacts with purchasers of wood products all the way from Bellingham to Salt Lake City. Due to unsettled worldwide conditions, markets were not too encouraging at first. The first business was done in July, 1940, when the manager obtained an order for fir piling. This order was soon followed by others, all of which were filled to the satisfaction of the dealers.

On the strength of this business, we finally received an order for 5 to 6 thousand Douglas fir telephone poles, and as many Douglas fir piling as we wished to deliver. In filling this order to the satisfaction of the dealers and our membership, we proved to the dealers our ability to deliver the goods, and to our membership, then about 60 in number, the fact that we could find markets. Since that time the manager has often embarrassed us with more business than we could handle.

* Read before the Forestry Section of the Northwest Scientific Association, Spokane, Washington, December 29, 1941.

While this association has only been in operation for about 18 months, we have done enough business to demonstrate several advantages of this method of marketing. In the first place there is a very great saving of timber. When the farmer sells stumpage, the logger taking out the product does not usually care what destruction is caused to the remaining standing timber. This is not so when the owner himself logs his timber.

Some time ago, I sold cedar poles on a stumpage basis; and in spite of the fact that the written contract definitely stated that there should be no undue damage to standing timber, the cutters often cut three or four smaller cedars or firs to get the one wanted. We are now logging our own timber and the past year have cut over 400 poles and piling with practically no damage to the remaining standing timber.

Then too, because of the volume of our orders, dealers have been willing to send out representatives who have visited the farms where cutting was taking place and have aided the farmers in interpreting the specifications, pointing out objectionable features, as spike knots, cat faces, etc. This has resulted in very few poles being discarded at the place of delivery. This, of course, saves much material, labor and cash outlay for transportation of cull material. Dealers often are forced to refuse a large percentage of products delivered. One pole representative with whom we worked last winter stated that his company had been forced to cull back more than 100 poles from a batch of 300 delivered.

The Soil Conservation Service, through the medium of complete farm plans which have been prepared for most of the member's farms, has also aided very materially by showing us the desirable trees to be cut, both as to the requirements of the trade and in relation to the rules of good silviculture.

We have been conscious of the skepticism of the dealers in the ability of the farmer to meet contracts, due to the lack of knowledge of market requirements, or other inabilities. The association is doing much to allay this lack of faith.

Another important saving which has been very apparent is the nature of the orders we have been able to fill due to the fact that we can deal in a much larger volume than an individual farmer could. Our pole orders included poles of lengths from 25 to 50 feet, and piling from 20 to 110 feet. This enabled us to utilize practically all of the tree from the stump up to a top diameter of 6 inches; whereas if one is cutting poles or piling of only one length, he can utilize only a small portion of the tree.

Of course, there is always some part of the tree which cannot be utilized for anything but firewood. Then, too, there are individual trees which, because of crookedness or numerous limbs, are of no commercial value except for stovewood. The Association is now taking initial steps to borrow money from the Farm Security Administration to make advances to farmers who wish to cut and yard out stovewood to cure until the next fall, when it can be marketed as dry wood at a premium of a dollar or more per cord. This will enable us to save many scores of cords of wood which would otherwise be a total loss, and in addition would be a fire hazard.

Most of our members do not have the necessary equipment to yard out or transport material such as logs or large piling. It is the policy of the Association to employ other members who are equipped to do this work. In this way we are serving each other to the advantage of all. It makes it possible for the member to make a job for himself and his regular help, during slack times in ordinary farm duties.

Our manager is a man with long experience in the woods and in business, and in addition, he has had some training in technical forestry. His experience, together with aid from the foresters of the Soil Conservation Service, has enabled us to produce a more standard product which will command a premium on the general markets. This standardization of products is one of the basic principles of cooperative endeavor.

I, however, would not be doing justice to the men who have fostered this movement and who have given unstintingly of their time and energy if I only emphasized the immediate pecuniary gains of our cooperative efforts.

While most of the members of the cooperative need the immediate returns from their forest products, they are also keeping in mind the welfare of the future of this, one of the most favored regions of the United States. The Association has very clearly and definitely in mind a permanent policy of sustained yield and selective cutting. Some members are looking far enough ahead toward a permanent forest policy that they are willing to increase and improve their forest holdings by new plantings.

Approximately 400,000 Douglas fir, cedar, and cascara have been planted on about 500 acres the last two years on land owned by farmers in our county. The farmers, in most inctances, have paid 50 percent of the initial cost of these trees. This speaks well for the new attitude many of these farmers have toward their timber holdings, when one realizes that many of them in the past have often looked upon their forest holdings as a hindrance to their normal farm operations.

Far-reaching forestry policies cannot be thoroughly established until the average farmer who has timber holdings can see that his timber, instead of being a hindrance to him in his regular farm operations, can be made to contribute to his annual farm income in a very material way and should therefore be considered as one of his regular farm operations. Finding a remunerative market for even limited amounts of forest products at frequent intervals will do more to engender and increase respect for timbered acres than any amount of philosophizing about a permanent forestry program. Taxes, interest, and farm payments are not met by theorizing.

The 1933 Census lists 99,000 acres of land owned by farmers in Snohomish County as not being cropped or pastured; about 50 percent of this land supports stands of second-growth forests.

Approximately 9,000 acres of these second-growth forests are signed up in our Association among its approximately 90 members. This amount is growing appreciably since we now have a full-time manager. One of the manager's duties is to investigate prospective member's timber holdings, and also ascertain whether the individual is willing to practice a sustained yield cutting policy, since the aid and cooperation of the Soil Conservation Service, through the medium of farm plans, is contingent upon the Association's ability to practice this policy.

The past year the Association has done well over $30,000 worth of business, most of which would have been impossible without an organization. This is no small item in the, too often, meager income of stump ranchers. This is aiding very much in making these farmers forest-minded. The plans adopted, together with the definite aid of federal foresters in the way of education along practical forestry lines, and in making much unavailable timber available by building trails for roads and firebreaks, are all making for a wholesome attitude toward forestry.

Our Association is, however, only a babe among the family of cooperatives. It must be fostered by Federal, State and local agencies until its numbers and experiences give it impetus enough to carry on by itself.

Some day our generation will stand criminally indicted before public opinion because of its profligate waste of the God-given rich natural resources of our land. Nowhere will that indictment be more deserved than in our Pacific Northwest region in the handling of our once wonderful forests. The problem of a conservative, long-time forestry program is of such magnitude and of such importance that it merits the combined efforts of national, state, regional and local forces. I firmly believe that cooperative selling of forest products will aid materially in solving this most important phase of conservation of our forest resources!

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THE DENSITIES OF AMMONIA SOLUTIONS OF LITHIUM AND CALCIUM METAL

LOWELL V. COULTER

Department of Chemistry and Chemical Engineering, University of Idaho

Liquid ammonia solutions of sodium and potassium metal possess densities which are considerably less than the pure solvent at the same temperature. These properties first quantitatively studied by Kraus, Carney and Johnson[1] in the case of sodium and later investigated by Johnson and Meyer[2] in the case of potassium have enabled these investigators to calculate the expansion per mol of metal when the metal is dissolved in liquid ammonia at —33° C. In each case this volume expansion, ΔV (ΔV = vol. of solution containing 1 g. atom of metal—vol. of solvent in pure state—vol. of 1 g. atom of metal in pure state) was found to exhibit a maximum of 43 c.c. and 30 c.c. for sodium and potassium respectively, at about 11 mols NH_3/metal when considered as a function of concentration.

On the basis of the Kraus[3] ionic theory i.e. the alkali metals undergo ionization in liquid ammonia to form solvated positive ions and solvated electrons; it would be expected that alkali metal ammonia solutions would have in common similar effects arising from an ammonated electron. That this is probably true for the expansions of the sodium and potassium solutions is easily demonstrated by taking into account the differences in atomic and ionic sizes of these two metals. Such a consideration leads to approximately the same ΔV values for sodium and potassium solutions.

As a further test of the applicability of the ionic theory to alkali metal solutions density measurements were made by the author on solutions of lithium metal and a saturated solution of calcium metal. The apparatus and procedure employed here, with a few modifications described below, similar to that described by Kraus.[1] A chainomatic Westphal balance and a pyrex bob of 2 c.c. were employed. The amount of ammonia used in each determination was measured from a small metal steel tank of about 50 g. capacity. Stirring of the solutions was attained by the use of a magnetic stirring device.

For the lithium solutions at —35°C. the following values of the density were obtained: 3.76 mols NH_3/Li (sat.) 04920; 4.285, 0.5065; 4.516, 0.5103; 6.432, 0.5435.

For the calcium solutions at —35°C. and at a concentration of 7 mols NH_3/Ca (sat.) the density was found to be 0.651.

By use of these data the ΔV function for lithium was found to vary, linearly, over the concentration range studied from 37.5 c.c. in the saturated solution to 41.4 c.c. in the more dilute region.

To compare the sodium and potassium solutions with the lithium solution, ΔV values at a common concentration of 6 mols NH_3/metal were selected and corrected to compare with lithium by taking into account the differences in atomic and ionic sizes of sodium and potassium. From the uncorrected values (Na, $\Delta V = 41.7$ c.c.; K, $\Delta V = 28.0$ c.c., Li $\Delta V = 40.8$ c.c.) the following corrected values were obtained: Na, $\Delta V = 47.4$; K, $\Delta V = 45$; Li $\Delta V =$ (40.8 c.c.). In view of the fact that ΔV is quite sensitive to experimental errors it seems likely that the three alkali metal solu'ions studied so far possess a common factor, probably the solvated electron, leading to similar anomalous expansions.

The experimental density datum for the saturated calcium solution yields a ΔV of 44 c.c. which may be compared with the sodium solution value 42.5 c.c. since the atomic and ionic radii of these two elements are quite similar. In the saturated calcium solution it seems likely, then, that but one electron per atom is ionized. This appears reasonable in view of the high ionization potential of the second electron.

[1] C. A. Kraus, E. S Carney and W. C. Johnson, Jour. Am. Chem. Soc. 49, 2206 (1927).

[2] Johnson and Meyer, Jour. Am. Chem. Soc. 54, 3621 (1932).

[3] C. A. Kraus, Jour. Am. Chem. Soc. 30, 1323 (1908).

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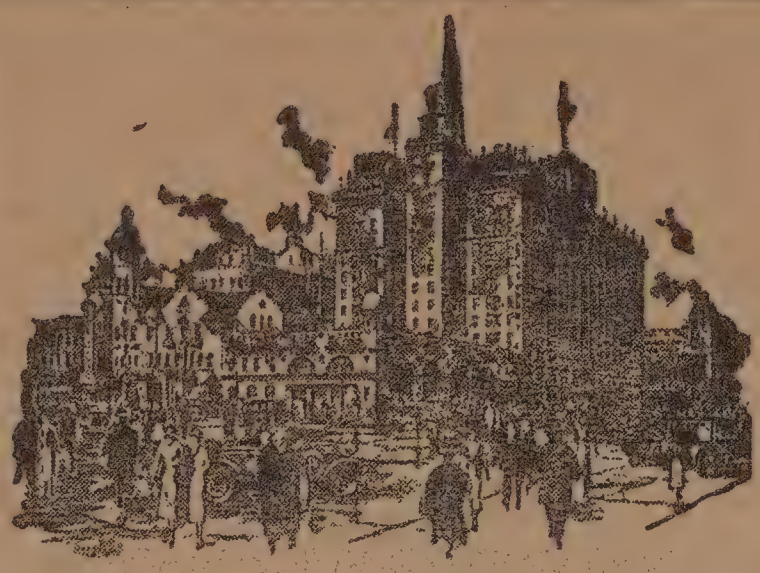

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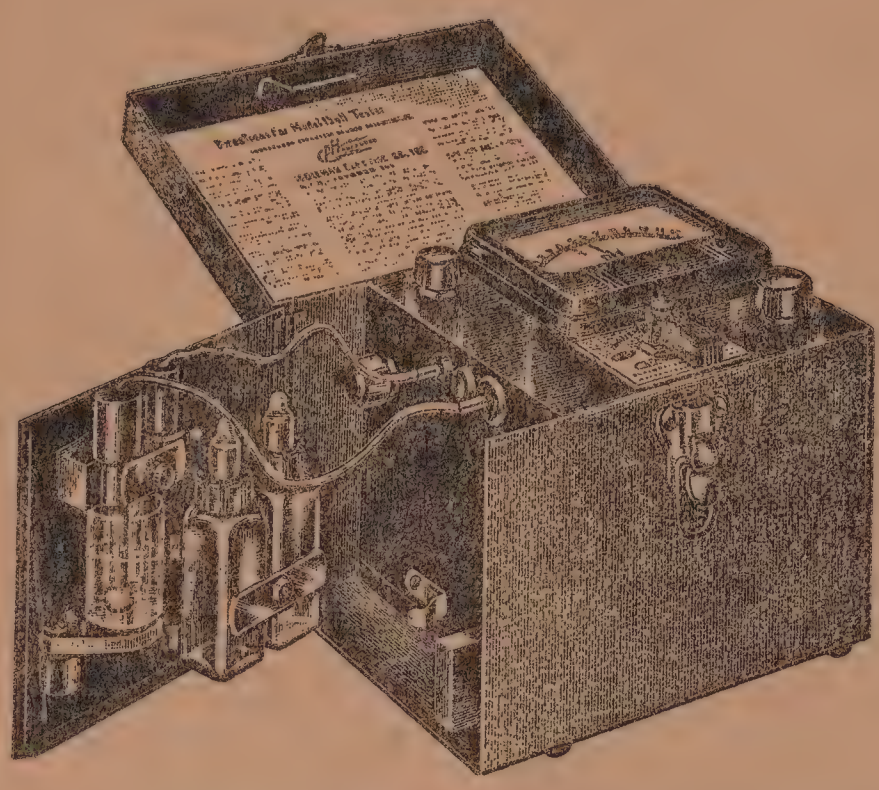

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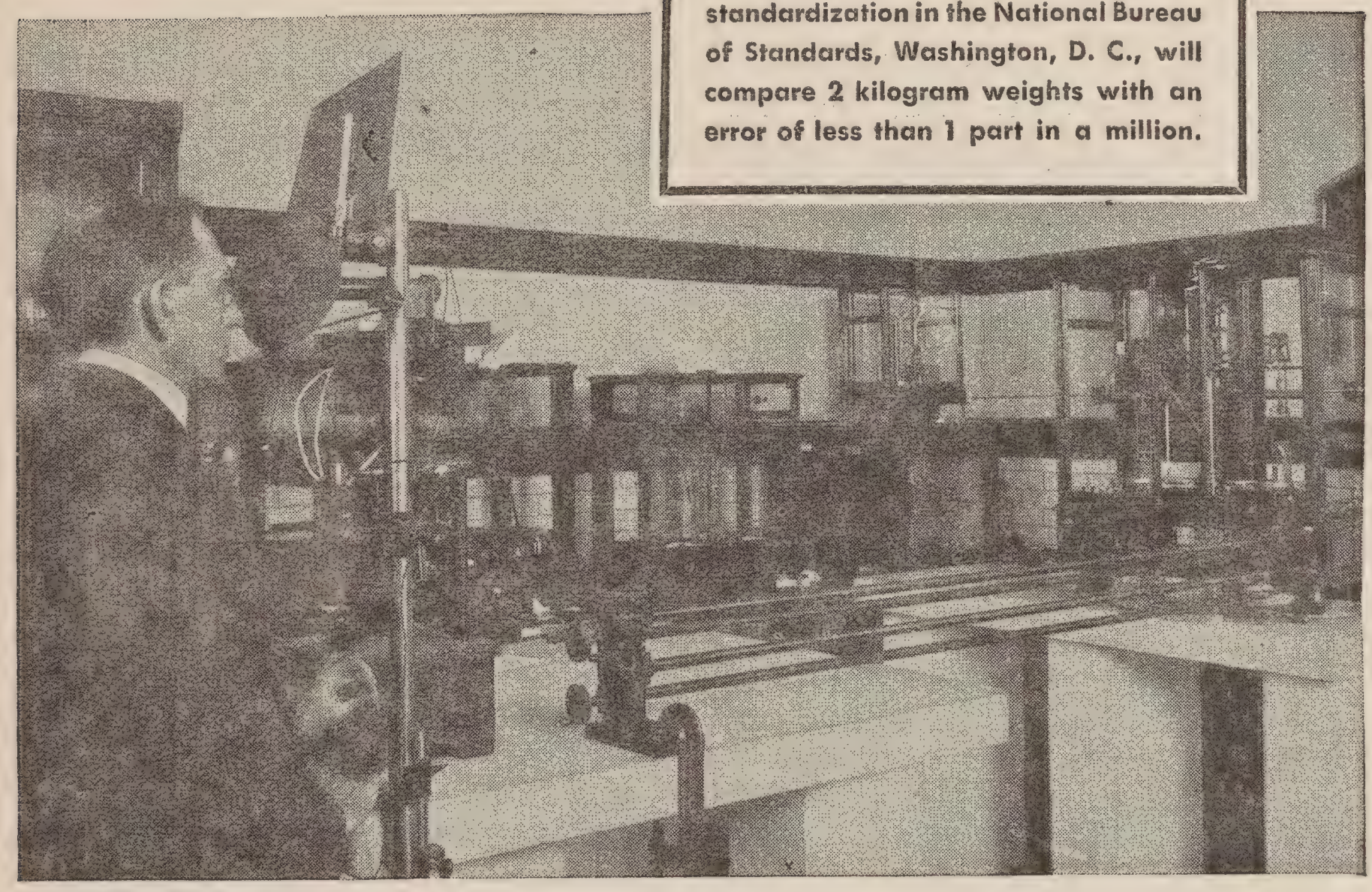

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1942 Meeting of the Northwest Scientific Association Cancelled

It is with much regret that the officers of the society announce that the program meeting of the Northwest Scientific Association scheduled for December, 1942, has been cancelled. This action was taken at a Council meeting held in Spokane September 19, to which chairman and secretaries of the section groups were also invited. Some 20 elected officers and several others interested were in attendance. The situation was thoroughly discussed. Difficulties of transportatioon, inadequate and uncertain hotel accommodations, the government's request that such meetings be cancelled unless essential, and the fact that a large number of our members are engaged in defense activities were all taken into consideration in reaching a decision.

At the same meeting, it was voted to retain the present officers "for the duration," or until successors can be elected. Research activities will be continued and grants made as usual. To help make this possible the Council urges that members make voluntary contributions to the research funds in order to continue present research projects. NORTHWEST SCIENCE will continue to be published as long as funds permit and contributions are available. Members are urged to send $1.00 for their dues to the Secretary, H. F. Raup, Cheney, Washington. Most of the money from dues is used to publish NORTHWEST SCIENCE. Members can also help by sending papers for publication to the editor, O. W. Freeman, Cheney, Washington.

The president of the Northwest Scientific Association, Dr. J. W. Severy, sends this message: "I do hope that there will be a relatively large number of our members who will continue the payment of their dues during the war emergency period. We must keep as strong a skeleton organization as possible if we are to be ready to go immediately after the war. The Northwest is going to have many problems in the post-war period and the solution of a large number of them will be dependent upon the research activities and the attitude of scientists. There will be need of unity, and the Northwest Scientific Association can serve as an agency which will bring these workers together."

-:- NORTHWEST SCIENCE -:-

Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

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Editor, Otis W. Freeman, Cheney, Washington

VOL. XVI, NO. 4 **NOVEMBER, 1942**

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PROPOSED REVISION OF THE CONSTITUTION OF THE NORTHWEST SCIENTIFIC ASSOCIATION

The undersigned members of the Northwest Scientific Association were appointed by the council to revise the Constitution of the Association. Our work consisted principally of codification. We are proposing to call the document merely The Constitution, which was the heading on the original, but in the text reference was made to by-laws, the terms being used interchangeably.

Article I. Reference to headquarters has been omitted. The committee was unable to determine what was meant by "headquarters."

Article III. The classification, **honorary member,** was added to the list.

Article V. Section 6. Although a regular plan of succession of council members has been in effect, we could not find that provision was made either in the Constitution or in the minutes of the Association. In the proposed new section the terms of all councilors are made three years except elections to fill unexpired terms. It is intended that the three year terms shall begin upon the expiration of present terms, regardless of the length of the term to which the councilor retiring had been elected.

Article VI. Under present provision the newly elected board of trustees retires to the corridor, hurriedly selects three additional nominees, returns to the main meeting and asks the Association to elect these three men for a period of one year only. Although thus hurriedly selected, and elected for only one year, these three are asked to serve as the excutive committee of the board. The recommendation of the committee is that all trustees be elected by the assembly at the same time and in the same manner. Further provision is made that the board of trustees shall select three of their number to serve as the executive committee of the board at such times as it is not in session. It is assumed that under this procedure the executive committee will each year have some holdover members.

Provision is made for three-year terms for all members, beginning on the expiration of present terms. In order to make the succession of board

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members uniform we recommend that the board be increased from eleven to twelve members, the increase being effected by the election of three instead of two honorary members.

Article IX. Method of amendment of the Constitution was changed to include approval of the council of proposed amendments.

C. C. TODD, Chairman.
JOHN EHRLICH
OTIS W. FREEMAN

CONSTITUTION OF THE NORTHWEST SCIENTIFIC ASSOCIATION

Article I. Name.

This society shall be known as the Northwest Scientific Association.

Article II. Purpose.

The purpose of the Association shall be the promotion of scientific research and the diffusion of scientific knowledge.

Article III. Membership.

Membership in this Association shall be divided into the following classes:

(1) **Member.** Anyone interested in the purpose of the Association may become a member on the annual payment of one dollar.

(2) **Institutional Member.**

a. State universities, colleges, and similar educational institutions. Annual dues, $25.00.

b. Normal schools, other educational institutions, and professional organizations. Annual dues, $10.00.

(3) **Life Member.** Life membership may be obtained on the cash payment of $25.00 or by paying $6.00 per year for five years.

(4) **Supporting Member.** Supporting membership may be obtained by a minimum payment of $100.00.

(5) **Patron.** Persons contributing $1000 or more to the Association shall be known as Patrons.

(6) **Honorary Member.** Chosen as provided in Article VI, Section 1.

Article IV. Officers.

The officers shall consist of a President, a Vice President, and a Secretary-Treasurer.

All officers shall be nominated by a committee or by members from the floor at the annual meeting.

Election shall be by ballot of members present.

Officers shall hold office for one year or until their successors qualify..

Article V. Council.

Section 1. The Council shall consist of the officers and five other members to be nominated and elected as provided in Article IV.

Section 2. The duties of the Council shall relate chiefly to conduct of meetings of the Association, the publication of programs, proceedings, journals or other publications of the Association and to other matters relating to the functioning of the organization as an active scientific society.

Section 3. The Council shall represent the Association between regular sessions in all matters not specially delegated to the Board of Trustees.

Section 4. It shall be the duty of the Council carefully to review the Annual Report of the Board of Trustees and to present this report to the general meeting of the Association, with recommendations.

Section 5. Nothing in this article shall be construed to limit the initiative of the Council in matters to be presented to the annual meeting of the Association.

Section 6. Tenure. After the first election the Council shall determine by lot which members are to serve for terms of one, two and three years. Thereafter election sholl be for terms of three years. Vacancies for unexpired terms shall be filled by election at the annual meetings.

Article VI. Trustees.

Section 1. The Board of Trustees shall consist of twelve members. Nine of the members shall be nominated and

elected, as provided in Article IV, from the active membership of the Association to serve for a term of three years. They shall be chosen for their understanding of the nature of research problems, activity in scientific research, or general ability in guidance of the conduct of research. Three shall be elected by the nine Trustees from the citizenship of the region served by the Association without regard to membership in the Association, but shall become honorary members on election. Honorary members shall be chosen for interest in scientific research, and for recognized ability in public affairs. Following the first election, the President and Secretary shall, by lot, divide the trustees into groups to serve one, two, and three years. Thereafter, all trustees shall be elected for terms of three years. Vacancies in the Board of Trustees shall be filled for unexpired terms by election for such term at the annual meeting of the Association. Following each annual meeting, the Board of Trustees shall select three of their number to serve as the Executive Committee of the Board at such times as it is not in session.

Section 2. The Trustees shall be the custodians of all real property of the Association and of all other property and funds belonging to it, except such as shall be held by the Council and the Secretary-Treasurer for the immediate functioning of the Association as an active scientific society.

Section 3. The Trustees shall furnish such bond as the Council shall decide, the expense of the bond being paid from funds of the Association.

Section 4. At the earliest feasible time the Trustees shall make known to the public the provision which has been made for the safety of the funds which may be intrusted to it. They shall also make known the purposes of the Association and the services it is prepared to render.

Section 5. The Trustees may, at their discretion, through the public press or by direct solicitations from individuals or organizations, call attention to the need of funds from other sources than public taxation for the prosecution of scientific research, the publication of the results of research, or for the preservation and use in museums and libraries of materials, manuscripts and books, for the prosecution of long-period research problems and for research programs of importance for which legislatures may not make appropriations.

Section 6. The Trustees share with the Council the right to take initiative for policies furthering the interests of the Association, but the Trustees shall make a report to the Council of their activities at least one month prior to the annual meeting of the Association.

Section 7. The fixed policy of the Association shall be friendly cooperation with existing institutions of the region served and particularly with member institutions. This provision shall be interpreted to include the various Federal and State bureaus, surveys, and services which are engaged in scientific work, as well as educational institutions.

Section 8. Trustees may hold any office in the Association except membership in the Council.

Article VII. Committees.

The committees shall be a Membership Committee, and other committees annually appointed by the Council.

Article VIII. Meetings.

The Annual Meeting shall be held at such time and place as the Council decides. Special meetings may be called by the Council.

Article IX. Amendments.

Amendment to this constitution may be made at any annual meeting by a vote of three-fourths of the members present and voting, provided notice of such amendment has been reported in the official program. Proposed amendments must be submitted in writing to the Secretary-Treasurer at least three months prior to the annual meeting. Proposed amendments presented to the Association must first be approved by the Council.

A POLLEN STUDY OF A FOSSIL PEAT DEPOSIT ON THE OREGON COAST*

HENRY P. HANSEN AND IRA S. ALLISON
Oregon State College, Corvallis

INTRODUCTION

Pollen profiles of a fossil peat bog, enclosed in terrace sands at the north end of Nye Beach, Newport, Oregon, reveal a sequence of plant succession from pioneer to climax forest in a sand dune region. The age of the peat is uncertain, because of the complex physiographic history of the Oregon Coast during Pleistocene and Recent time. The earliest recorded forests, however,, indicate that the sediments of this study had an earlier origin than living bogs in the same general region. The erosion cycle of a submerged shoreline during the post-Pleistocene, has created and is creating favorable topographic conditions for the initiation and continued development of hydrarch plant succession. Many lakes and ponds have been formed as a result of blocked stream drainage by shifting shore-sand and the formation and migration of sand dunes. Some of these lakes are more than a mile inland and separated from the ocean by dunes a hundred feet or more in height. In many cases the sand dunes have become stabilized by plant growth, at least temporarily, and support various stages of xerarch plant succession. Likewise the lakes, entrapped by dunes, support many stages of hydrarch succession, from submerged to climax bog seres. Where sufficiently removed from the interplay of shore agents, the climax forest has been attained on both bog and dune. Nearer the ocean, however, dunes seeminngly stabilized by plant cover may begin to migrate, burying forest and bog, and filling lakes and ponds. Later, continued shifting of the dunes may exhume the buried forests and bogs. Thus, plant succession, both xerarch and hydrarch, may be interrupted, and all traces of its stages obliterated by the shifting sand.

In general the first plants to invade the dunes are forbs and grasses whose rhizomes, stolons, and rootstocks tend to hold the sand. They are followed by shrubs, consisting largely of the ericads salal (**Gaultheria shallon**), manzanita (**Arctostaphylos columbiana**), bearberry (**A. uva-ursi**), huckleberry (**Vaccinium ovatum**), and rhododendron (**Rhododendron macrophyllum**). Wax myrtle (**Myrica californica**) is also common during the shrub stage. Simultaneously with the shrubs or later, lodgepole pine (**Pinus contorta**) is the first arboreal invader, followed closely by Sitka spruce (**Picea sitchensis**). After the edaphic conditions have been modified and a windbreak of pine and spruce formed near the ocean, western hemlock (**Tsuga heterophylla**) may enter, and lodgepole pine gradually lose out because of its intolerance for shade. When the climax forest is disturbed by fire, Douglas fir (**Pseudotsuga taxifolia**) makes its appearance and may become locally predominant until it also is replaced by spruce and hemlock.

Occurrence of the Peat.

The peat is exposed in the fresh face of the sea cliff immediately east of the former site of Jump-off-Joe (a wave-tunneled residual later destroyed by wave erosion) at the north end of Nye Beach at an elevation of about 80 feet above sea level. This peat can be traced along the cliff for a distance of a few hundred feet. It can also be followed northward, eastward and southeastward around a small spur into a ravine leading to the beach. Except as reworked materials it seems to be absent from the other side of the ravine, thus suggesting that the original deposit was relatively small, perhaps

*Published with the approval of the Monographs Publication Committee, Oregon State College, as Research Paper No. 70, School of Science, Departments of Botany and Geology.

The expenses of the project were defrayed by a grant from the General Research Council of Oregon State College.

occupying only an acre or two, although its former extent seaward is not known. Its maximum exposed thickness is about 3 feet; but as it thins toward the limits of the exposures, its average thickness is about half as much.

The bulk of the peat, especially in its lower parts, is relatively compact, fine-grained and apparently structureless. Here and there, however, particularly near the top and near the southern edge of the deposit are well preserved logs, burl, stumps with spreading roots and recognizable bark, aggregates of conifer needles and similar xyloid material. Such wood is merely stained brown, not carbonized. As the logs are prostrate and do not extend into the sands above, the trees evidently were not standing at the time of the deposition of the cover of sand.

Stratigraphic Relations and Age of the Peat.

The major geological problem is to determine the stratigraphic position and geologic age of the deposit. An offhand view suggests that the peat-bearing sands are merely a part of a marine terrace that extends along the greater part of the)Oregon coast and that has generally been referred to some part of Pleistocene time (Diller, 1896; Smith, 1933). The complexities possible along the Oregon coast, involving Pleistocene and Recent eustatic changes of sea level, coastal uplift and warping, trenching of marine terraces by streams extended across them, later drowning and partial filling of these valleys, alternations of cutting and fillinng, deposition of alluvial fans and related deposits on the terraces, shifting of stream mouths by shore deposits of sand, the landward migration of shore dunes and other complications arising from the interplay of diverse forces and agents, make one wary of such a simple explanation. Unfortunately the limited facts available do not permit an unequivocal conclusion.

The terrace sands lie nearly horizontally across the beveled edges of the Nye shales which dip westward at an angle of about 20 degrees. The Nye Shales, carrying **Acila gettysburgensis** Reagen, **Bruclarkia gravida** (Gabb), fish scales, a fe wforamenifera, etc., are Upper Oligocene or Lower Miocene in age (Schenck, 1928; Packard and Kellogg, 1934). The base of the richly fossiliferous marine "Astoria" Miocene beds, formerly passing through Jump-off-Joe, has been transgressed locally by wave erosion and now lies a few hundred feet seaward from the present beach. The base of the terrace sands is about 60 feet above sea level and the edge of the terrace at the top of the sea cliff is about 100 to 125 feet above sea level. Stabilized dune sands are widespread on the terrace in this vicinity. The clayey and impermeable character of the seaward-dipping Nye shales, being undercut by the waves, induces numerous slides so that a jumble of small slip-blocks, some of them including peat, composes the slope between the receding cliff face and the beach.

The sand immediately underlying and overlying the layer of peat is rather even-textured, hence bedding is indistinct but apparently generally parallel and probably subaqueous in origin. Whether it is lacustrine, fluviatile or marine is uncertain. Cross-bedding is local, minor and not diagnostic. No fossils except of plants were found in the sands. Apparently the peat bog was formed on a fairly smooth sandy plain and eventually was buried by a sheet of waterlaid (?) sand. A thin seam of additional peat exposed about two feet above the main layer in the ravine mentioned above suggests a minor repetition of these processes. Stream-laid gravels and wind-laid sands nearby indicate a complexity of origin of the terrace deposits.

The modern analog of these peat-forming conditions is probably best exemplified by bogs associated with the lakes near Florence, Oregon, about 50 miles to the south, where lakes and ponds are numerous—some in drowned valleys blocked by shore drift of sand,

some in depressions between or behind dunes, etc. (See Heceta Head and Siltcoos Lake topographic maps, U. S. Geol. Survey.) These lakes, some with bogs at their borders, range in elevation from a few feet above sea level (as Siltcoos Lake, 5 feet; Tahkenitch Lake, 5 feet) to several tens of feet above sea level (as Threemile Lake, 18; Woahink Lake, 36; Mercer Lake, 39; Clearwox Lake, 82; Munsel Lake, 92; Clear Lake, 98; Collard Lake, 108 feet). Numerous small ponds, potentially the sites of bogs, lie at various intermediate elevations. The present elevation of the peat in the cliff at Newport therefore cannot be used as an argument for uplift of the terrace since the peat was formed. It may have been formed at its present level (or even higher) subsequent to the formation of the terrace. On the other hand it may have been deposited during a temporary low stand of sea level before the cutting of the terrace and deposition of terrace sands had been completed and the terrace uplifted. The corresponding range in age likewise extends from the comparatively recent past (when the shoreline lay perhaps several hundred to several thousand feet or more farther west, say a few thousand years ago) to some indeterminate time in the Pleistocene (tens of thousands of years or more ago).

In the discussion thus far, the sea terrace has been treated as an entity of a single age, whereas actually it appears to be composite. Furthermore one must distinguish between the wave-cut terrace and the deposits on such a terrace. Probably most of the deposits on the terrace are not marine, but are fluviatile, eolian, etc. The principal terrace, a mile or more wide and at its landward edge 250 to 350 feet above sea level, slopes westward toward the sea and has been considerably dissected by streams. It was formerly covered with timber and brush, now partly cleared. Some bench-like areas near the sea lie at lower elevations and appear to be remnants of other, lower terraces (not to be confused with landslides) that originally may have had much greater extent seaward. The peat at Newport is in just such a bench now standing a little more than 100 feet above sea level. If, as seems likely, the peat is younger than a 75 to 100-foot terrace adjacent to older, higher and more dissected terraces, its probable age is correspondingly reduced, but no correlation of such terraces or terrace coverings in Oregon with the Pleistocene stages elsewhere has been attempted or seems justified by present knowledge.

A conservative conclusion is that the peat was formed on an exposed coastal terrace, probably in Recent, but possibly in late Pleistocene time.

Methods and Technique.

Samples were obtained at six inch intervals at two sites. One profile was obtained from an exposed face of the peat stratum **in situ** in the sea cliff. The thickness of this layer, including the pollen-bearing sand underlying the organic peat, is about 3 feet. Another profile was obtained from a four-foot stratum, a block of which had slumped down to the beach, and remained intact. The greater thickness of the slipback suggests that the bog became deeper seaward, and that the major portion of it had been eroded into the ocean with the receding sea cliff. This is further substantiated by the thinning of the layer toward the eastern limits of its exposure as previously mentioned. In preparation of the peat for microscopic study, the potassium hydrate method was used. Although the peat was not carbonized, it was slightly lignitic, and it was necessary to pulverize it with a mortar and pestle before boiling. One-hundred fifty pollen grains were identified from each level, and pollen was very abundant. In the identification of the Pinus pollen, the size range method was employed (Hansen, 1941a, 1941b, 1941c). A few pollen grains were discarded because their dimensions fell within the limits of overlap between those of lodgepole and western white pine (**Pinus monticola**). These, however, were probably also of

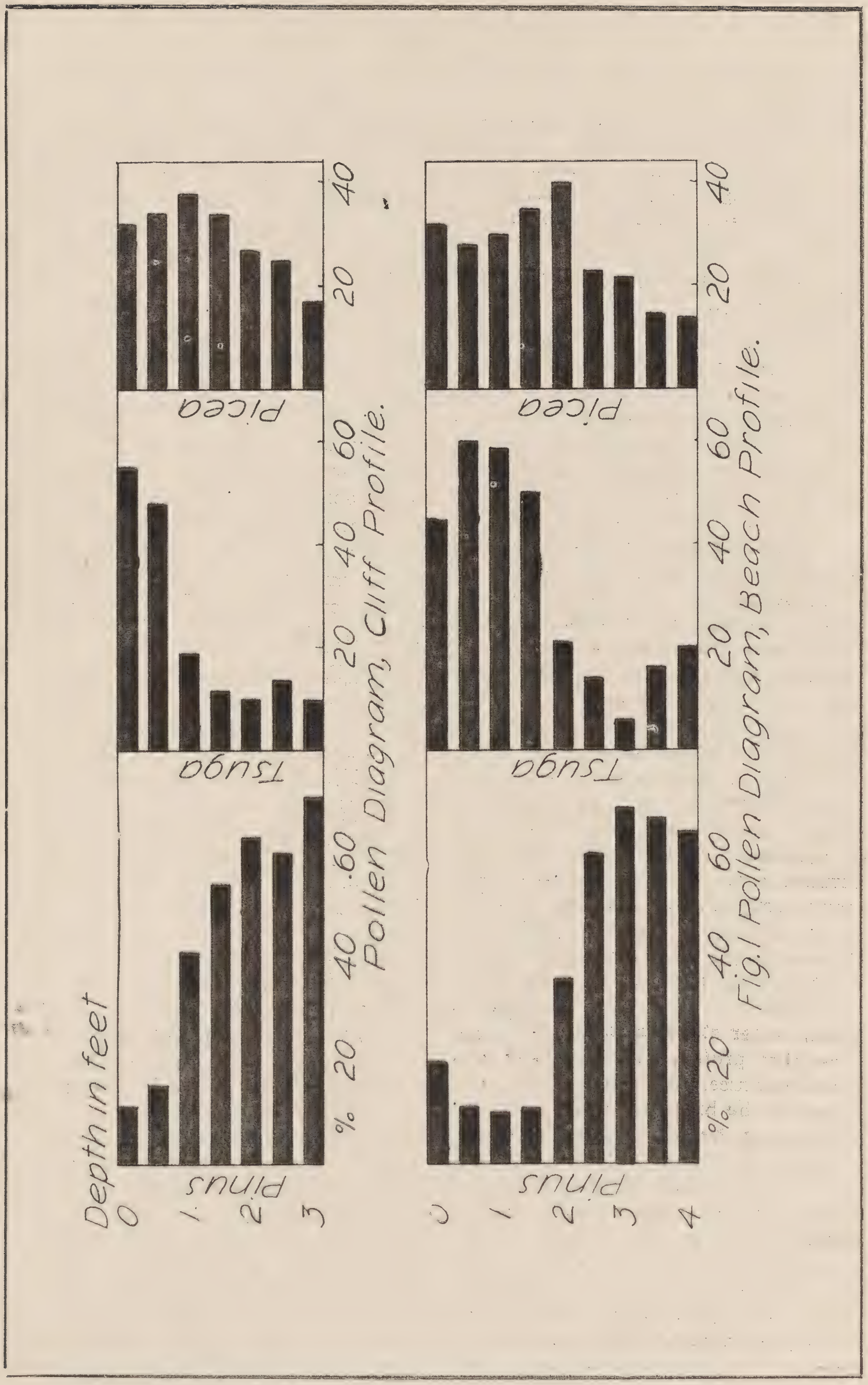

Fig. 1 Pollen Diagram, Beach Profile.

lodgepole pine. Fir pollen is listed as that of lowland white fir (**Abies grandis**), and is too scanty to be of any significance.

Interpretation of the Pollen Profiles.

The forests within range of pollen dispersal to the bog when the lowest sediments were deposited consisted chiefly of lodgepole pine, Sitka spruce, and western hemlock. These species are the principal dominants of the present day forests along the northern half of the Oregon Coast. Lodgepole pine was predominant and is recorded to 71 per cent in the cliff profile and 64 per cent in the beach profile. In the cliff profile, spruce and hemlock are recorded to 17 and 10 per cent, and in the other profile to 14 and 20 per cent respectively at the bottom (fig. 1. Lodgepole declines sharply from its maximum at the bottom to 11 per cent at the top of the cliff profile. In the deeper profile, it increases slightly from the bottom to 3 feet, sharply decreases to 10 per cent at 1 foot, and then increases to 20 per cent at the uppermost level. Spruce increases from its minimum proportions at the lowest level of both profiles to its maximum of 38 and 40 per cent, and then it declines to the top where it is recorded to 32 percent in both profiles. Hemlock remains rather static in the lower half of the cliff profile, then increases to supersede spruce, and is recorded to 55 per cent at the highest horizon. In the beach profile, hemlock decreases from the bottom to 3 feet, then increases to supersede spruce and attains its maximum of 60 per cent at 0.5 feet, and then declines to 45 per cent at the top. Hemlock exhibits the lowest proportions of the three species, but also attains higher proportions than spruce, and is predominant in the uppermost horizon (fig. 1). Thus, from a pioneer forest consisting largely of lodgepole which invaded a sand dune area, forest succession reached a climax composed chiefly of spruce and hemlock, the dominants of the present Oregon Coast forests. Douglas fir, also one of the lesser dominants, is not represented by its pollen in the profiles. Other species recorded in low proportions are lowland white fir, alder, and maple. Sedge, grasses, composites, water-lily, and ericads are also sporadically represcally represented in low proportions. The presence of water-lily pollen in the lower levels of both profiles, reveals that the hydrarch succession began in a body of water.

That lodgepole pine is a pioneer invader of areas that are physiographically unstabilized is shown by its invasion of recently deglaciated areas in many parts of the Pacific Northwest, and of pumice-mantles in the central Cascades of Oregon (Hansen, 1938, 1939, 1940a, 1940b, 1941a, 1942a, 1942b). In the Willamette Valley of western Oregon, which was unglaciated, lodgepole was also the pioneer invader and was predominant during the early postglacial (Hansen, 1942c). The unstabilized conditions caused by the inundation of the Willamette Valley by backwater from the glacial-swollen Columbia River (Allison, 1935), and the increase in water from melting glaciers in the Cascades were unfavorable for other species. The lack of competition permitted lodgepole to thrive until the physiographic conditions were stabilized and other species gained a foothold. There is no lodgepole in the Willamette Valley today, and it was apparently absent when white man first settled the valley.

The depth of the exposed peat stratum is comparatively thin, but its seaward extent is unknown. If the layer constitutes the eastern border of the original bog, it may have been several times deeper farther west in the center. The presence of tree stumps and roots **in situ,** cones, and conifer needles of spruce and hemlock indicate that this portion of the bog had reached a climax and that little or none of the original surface was truncated by subsequent erosion. The weight of the overlying sand and the normal compaction of the peat itself, suggest that

the original thickness was greater than the buried stratum. The amount of time required for its deposition is uncertain. The rate of post-Pleistocene peat deposition in the Pacific Northwest has varied from 500 to 1500 years per foot, depending upon the climate and the type of vegetation contributing to the peat. In the wet climate of the Oregon Coast, the rate has probably been rapid, and 500 years per foot would be reasonable. If the peat stratum has been compacted to one-half of its original thickness, about 4,000 years for its deposition was required. Forest succession from pioneer forests of lodgepole pine to a spruce-hemlock climax during this interval, lends support to these figures.

Another means of dating the past stratum is available. Pollen analyses of two living bogs along the Oregon Coast have been made, and a comparison of their pollen profiles with those of this study shed considerable light on their relative ages (Hansen, 1942c). One of these bogs is located on the margin of Woahink Lake, about 50 miles south of Newport, and the other at Sand Lake, about 50 miles to the north. Both of these bogs and the peat stratum of this study lie within areas of similar physiographic, climatic, and floristic characteristics. The sequence of physiographic events leading to the ponding of water and subsequent hydrarch plant succession also have apparently been similar in the three cases. The depth of the Woahink bog is 12 meters, and spruce and hemlock have been predominant during the time represented by the profile. The greatest proportion to which lodgepole pine is recorded is 21 per cent at .25 meters, and the average for this species in the lower 6 meters is about 5 per cent. In the Sand Lake bog, lodgepole is also recorded in low proportions throughout, with the exception of the surface, where it attains 51 per cent. In both bogs the increase of lodgepole as recorded in the upper levels is probably a result of its invasion of the bog surface and recently denuded areas. This species also occupies young dunes between the bogs and ocean, and prevailing westerly winds should cause an abundance of its pollen to reach the bogs. Its relative absence, however, tends to show that the presence of local stands of lodgepole pine on younger dunes is ont reflected in the pollen profiles sufficiently to distort the normal representation of the climax forests that exist over most of the Oregon Coast area.

The existence of climax forests during the entire period represented by the Woahink and Sand Lake bogs, suggests that they had their inceptions at a later time than the buried peat stratum of this study. This apparently was after most of the coast region had been stabilized sufficiently to support a climax forest, whereas the buried peat was initially deposited when the adjacent areas were still in a pioneer lodgepole pine stage of succession. As previously stated the stratigraphic relationships fail to definitely date the peat stratum. It may have been laid down in Recent or late Pleistocene. The physiographic setting and depth of the Woahink bog, suggest that it represents most or all of the post-Pleistocene (Hansen, 1941c). The existence of climax forests adjacent to Woahink Lake when its lowest pollen-bearing sediments were deposited indicates that the dune area had already been stabilized. Notwithstanding the possibilities of local forest succession on younger dunes being recorded in adjacent accumulating peat, it seems probable that the buried peat had its origin early in Recent or in late Pleistocene time, before the beginninng of the above mentioned living bogs. It is possible that the upper levels of the buried peat stratum overlap in time with the lower horizons of the living peat deposit, as they both record the dominants of the climax forests in about the same proportions. A lapse of considerable time may also have occurred between the cessation of sedimentation in the fossil bog and the beginning of deposition in

the modern bogs. If the pioneer invasion-forest of lodgepole pine as recorded in the fossil peat was representative of the entire coastal area at that time, it may indicate that Pleistocene glaciation to the north was previously responsible for a climate unfavorable for forest growth in the dune zone. A lower sea level during the Pleistocene may have provided a wider zone of shifting sand. Winds may have been stronger than today, preventing the stabilization of dunes and development of a forest cover. As the glaciers waned, the climate became more equable, the strong winds subsided, much of the exposed beach was inundated as the sea level rose, and conditions in general became more favorable for stabilization of dunes and forest growth. This may have occurred in late Pleistocene or early Recent time. The fossil peat deposit may have had its origin in late Pleistocene, and its deposition continued into Recent time.

Summary.

A layer of peat imbedded in terrace sands on the central Oregon Coast records by the pollen therein, succession from a pioneer forest of lodgepole pine to a climax forest of Sitka spruce and western hemlock in a sand dune region. The age of the peat is uncertain, but the stratigraphic relations suggest that it was formed on a sandy plain probably during Recent or possibly late Pleistocene time. Pollen analyses of living bogs on the coast that lie within similar physiographic setting, indicate that the fossil peat had its inception as a bog earlier than they. The predominance of lodgepole pine when sedimentation began denotes that unstabilized physiographic conditions due to migrating sand dunes were existent in adjacent areas. It is possible that glaciation in other parts of the continent was indirectly responsible for the absence of forests in the coastal zone during the latter part of the Pleistocene. There is continual shifting of dunes in this coastal area today, but its effect on forest succession has evidently been too localized to be recorded in accumulating peat deposits. This is substantiated by pollen analyses of modern bogs in the same general region. It is possible that the upper levels of the fossil peat stratum is synchronous with the lower horizons of the living bogs, because the latter show that a climax forest existed when they were initiated. There is no evidence for climatic trends during the depositional interval of the fossil peat.

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SUGGESTIONS FOR A RESEARCH PROGRAM FOR THE UNIVERSITIES AND COLLEGES OF THE PACIFIC NORTHWEST

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Northwest Regional Council

The war is having certain strong impacts on the economy of the people of the Pacific Northwest—impacts which undoubtedly will increase rather than decrease in number and strength as the war goes on. They will raise problems of reconstruction, readjustment, and development which must be faced in the post-war period. Under these conditions it is desirable that as much current and prospective research as is practicable should be directed toward the understanding and solution of these problems.

In an unpublished study of the National Resources Planning Board, the field of desirable research has been outlined under the following heads:

1. Plans for demobilization
2. Plans with private enterprise
3. Plans for public activity
4. Plans for economic security
5. Population and manpower
6. Plans for financing and fiscal policy
7. Plans for regional, state, and local participation
8. Plans for government
9. Plans for international collaboration

Many problems in post-war planning are so large that they can only be undertaken by the government—national or state, or both. Many of them will require the cooperative effort of several agencies, public and/or private, comparable with what is being done in the Columbia Basin Joint Investigations. The role that faculty members of the several institutions of higher learning may play is well demonstrated by what such scholars have done and are doing in the Columbia Basin Studies, and by the several projects now in progress that are being sponsored by the various planning commissions and the National Resources Planning Board. By working in cooperation with one of the established federal or state agencies, the mature research student can find an outlet for constructive work in any of a number of specialized fields concerned with post-war regional problems.

It is also possible to draw well trained graduate students into the picture. Such persons could, under proper guidance, work upon segments of problems as seminar training and/or thesis topics.

Post-war regional problems offer a fruitful field of study for graduate seminars in which qualified technicians might play an important role as consultants.

In line with one of its basic purposes, the Council would like to aid in fostering and correlating research that will contribute toward the solution of post-war problems and toward a better and more secure region in the post-war era. Accordingly, to promote thought and criticism, as well as to promote the development of research programs of maximum value in the region's Universities and Colleges, this memorandum has been prepared.

The following outline, suggestive rather than complete, deals with these fields of interest:

1. Problems relating to industry
2. Problems relating to land-use
3. Mining and mineral research
4. Urban studies
5. Problems affecting both urban and rural areas
6. Transportation facilities and problems
7. Hydro-electric power
8. Population and migration

A. PROBLEMS OF INDUSTRY

Significant, far-reaching changes are taking place in the industrial economy of the Pacific Northwest. Old established industries are booming.

New industries are being introduced. Of major import to the region is the problem of converting these "war babies" into "peace babies." Intensive industrial research designed to discover the nature of the industrial pattern that is best suited to the needs and resources of the Pacific Northwest is vitally important.

1. Analyses of the old established industries to determine war time trends, probable post-war conditions, and the desirable readjustments necessary to meet them.
   a. Lumber
   b. Plywood
   c. Wood pulp
   d. Airplane industry
   e. Food processing
2. Analyses of war-induced industries, e.g., aluminum, magnesium, chemicals, shipbuilding, plastics, etc. to determine:
   a. Factors affecting their survival:
      1) Labor market—numbers, skills
      2) Costs of labor, materials, power, transportation, etc., compared with those in eastern areas
      3) Relative costs and difficulties of financing industry in the Pacific Northwest
      4) Regional versus external controls
   b. Conversion and reconstruction necessary to adapt them to peace-time demands
      1) New outlets for products of plants now engaged in war production
      2) Necessary changes in physical and human equipment to facilitate the transition from a war- to a peace-time economy.
3. Technical studies concerned with the development of new processes through which more effective use can be made of actual and potential resources of the region:
   a. Wood products
   b. Chemurgy
   c. Food processing
   d. Electro-chemical and electro-metallurgical industries, with reference to low-grade ores and minerals that are to be found in the Pacific Northwest.
   e. Fuel studies particularly relating to Northwest coals
   f. Flax
4. Analyses of Labor Force in the Pacific Northwest
   a. Personnel studies of the major industries of the region:
      1) Age groupings
      2) Education
      3) Vocational training and experience
      4) Previous occupation or occupations
      5) Preference, if any, regarding future employment
      6) Nature of retraining to fit them for desired employment
   b. Migration of labor:
      1) Occupational shifts
      2) Residential shifts
   c. Labor-management relations in the several industries of the region.

B. LAND-USE PROBLEMS

Among other things, the present war economy calls for increased production of foodstuffs. This may mean that farm soils will be subjected to mining and improper tillage; that lands unsuited to intensive agriculture will be cleared and plowed; that ranges will be too heavily stocked with animals. There is grave danger of losing much that has been gained in the way of better land-use practices; that some of the progress towards the development of a sound agricultural program will be lost. At the end of the war there may be a swing of people back to the land that may have some harmful results, if excessive or uncontrolled. Consequently, intensive research on land-use problems, regional, sub-regional, and local, from both a physical and economic point of view, is necessary.

1. An analysis and appraisal of present agricultural production in the

light of probable post-war conditions and needs.

a. Present land use
b. Changes in the agricultural program brought about by war-time demands
c. Means by which diversified cropping may be encouraged
d. Particular types of crops that should be encouraged
e. Measures for gearing agriculture into the regional industrial pattern, e.g., chemurgy, food processing, etc.

2. Detailed land-capability studies to provide information essential to a more effective utilization and management of land.

a. Detailed land-use, land capability studies of critical areas which would take into consideration both the physical and economic factors involved. These might duplicate on a small scale the techniques being used in the case of the Columbia Basin Joint Investigations. They might utilize the methods of community self-analysis as developed in the Elma and Skagit studies.
b. Cooperative comprehensive area-analyses designed to present an over-all picture of large areas and to provide the ground work for more detailed studies of sub-areas.
c. Detailed studies of critical drainage basins with a view to determining existing water supplies and the measures essential for their wise use and management.
d. Studies of land ownership—of the problems involved in the present ownership pattern with a view to the formulation and practice of more effective land management policies.

3. Detailed studies of conservation problems from which should emerge concrete and practical measures for dealing with the problems of local areas—drainage basins, soil conservation districts, irrigation districts.

Similar studies in conservation are necessary in the case of range, forest, water, fish, wild life, and recreation resources, in order to promote effective management. All such studies should involve both the physical and the economic aspects.

4. Land development in relation to needs in the post-war period

a. An estimate of the post-war need for farm land
b. Studies of specific areas in which reclamation should be given priority (based upon data now available)
   1) Determination of areas in which new or increased settlement facilities are desirable and practicable
   2) Capacity of land susceptible of reclamation to absorb settlement
   3) Desirable land use in areas to be developed, based upon land capability and economic considerations
   4) Formulation of definite settlement plans in advance of occupancy

C. MINING AND MINERAL RESEARCH

Detailed knowledge of the extent, quality, and geological circumstances of the region's mineral resources is lacking. This calls for intensive geological surveys. Known resources are, in general, of low grade or they occur in complex chemical combination. Their commercial use is, in part, dependent upon the development of special processes which will permit their economical production and more effective utilization.

Particular emphasis should be directed to the heretofore untapped mineral resources of the region—high alumina clays for aluminum, magnesite for magnesium, chromite for ferro chromium, phosphates for fertilizer, and iron ores for local steel production, etc.

1. Intensive geological surveys of known mineral occurrences to determine:
   a. The extent and richness of the deposits
   b. Geological conditions under which the deposit occurs and their relation to mining operations, both physical and economic.
2. Laboratory research concerned with the development of economical processes for recovering the specific mineral in question
3. Pilot plant research to prove the commercial feasibility of laboratory techniques

D. URBAN STUDIES

Systematic urban and metropolitan studies, each identified with an immediate problem but forming a definite part of a comprehensive research program, should be undertaken. In many communities, the shift and/or expansion of industry, war and postwar migration, etc., will create serious problems of rehabilitation, reconstruction, and conversion. In addition, long delayed but necessary modernization and reconstruction not directly connected with the war effort, e.g., terminal facilities, blighted areas, etc., should receive thoughtful study. Together, these would all be basic to the development of a master plan for physical, social, and economic betterment.

It would be desirable for these studies to be carried out in cooperation with the local, state, and regional planning commissions. Such studies might include:

1. The economic base
2. Blighted areas and rehabilitation
3. Housing
4. Sanitation
5. Traffic and transportation
6. Utilities
7. Health and recreation
8. Planning and zoning
9. Rurban studies (urban-rural fringe)
10. Consolidation and simplification of government functions

E. STUDIES OF PROBLEMS AFFECTING BOTH URBAN AND RURAL AREAS

These might be concerned with problems such as sanitation and pollution abatement, inter-urban transportation, public utilities and essential services. Illustrative of this group might be a series of pollution abatement studies in critical areas such as the Lower Willamette River, Cowlitz River, and Puget Sound.

1. Pollution abatement studies

With numerous of the Northwest's new industries attracted to tidewater and river locations, and the output of established stream-bank industries greatly increased due to the war, research by the engineering personnel of the Universities might well be undertaken into the pollution problems, if any, occasioned by this industrial expansion. On selected streams, for example, studies could be made of pollution due to (a) industrial causes (b) community influences. Technical studies looking not only toward pollution abatement and public health, but also to the conservation of waste materials, wild life, recreation, etc., are particularly needed. A careful scientific survey of the Pulp and Paper industry in relation to stream pollution will illustrate this type of investigation.

F. TRANSPORTATION FACILITIES AND PROBLEMS

Detailed studies of the transportation web of the Pacific Northwest should be made with a view to determining the readjustments that are necessary (a) to promote effective coordination of the various types of facilities available, (b) to eliminate uneconomic duplication, and (c) to reduce freight rates, in order that the region may be more adequately and economically serviced as a whole. Such studies might include the following aspects:

1. A critical analysis of railroad facilities of the region.

2. The development and potentialities of Columbia River navigation.
3. Detailed analyses of transportation facilities and problems in major urban centers in the light of present day requirements. Such studies should take into consideration modernization of equipment, unification of competing systems, and coordination of all facilities, with a view to securing optimum public convenience in both service and operation.
4. A critical appraisal of existing air communications within the region to determine the pattern for future development in keeping with the needs of the area.
5. The movement of freight by air—intra-regional, inter-regional, and international aspects—in the post-war period.
6. Coast-wise transportation facilities and trade—desirable readjustments.
7. Inter-coastal transportation facilities and trade—desirable readjustments.
8. The Alaska trade routes.
9. The coordination of rail and road transportation for the more effective and economical movement of regional commodities.

G. HYDRO-ELECTRIC POWER—ITS DEVELOPMENT, MANAGEMENT, AND UTILIZATION

The expansion of hydro-electric power facilities is intimately bound up with the present and with post-war industrial development. The role which hydro-electric power will play in the post-war economy needs detailed study.

1. The management of these power facilities, whether by the government alone or by government and private agencies, is a vital concern of the region. Every aspect of this problem should be carefully examined with a view of determining the most effective policy for the production, distribution, management, and ownership of this major resource.
2. The utilization of power needs continuing study, particularly with a view of determining how Columbia River power can be employed to the fullest extent over the widest area possible after the war. This problem is intimately linked with post-war industrial development, with rural electrification, and with the expansion of domestic demands. These aspects call for technical as well as marketing research.

H. POPULATION AND MIGRATION

1. Studies of the extent and distribution of the war-time migration to the Pacific Northwest. Data of this nature will be invaluable to the formulation of sound post-war rehabilitation problems.
2. Character and composition of Northwest population. This would include the following statistical information:
   a. Birth rates
   b. Proportion of children under five years of age to total
   c. Population
   d. Marriage rates
   e. Divorce rates
   f. Age groupings of population
3. Resettlement problems resulting from post-war industrial readjustments.
   a. Urban (major urban agglomerations)
   b. Rural

   Such studies would have as their starting point the research already done by the Pacific Northwest Regional Planning Commission on the development of economic opportunity in the Pacific Northwest. Such studies will undoubtedly call for cooperative action on the part of several local, state, and federal agencies.
4. Resettlement problems of the dispossessed enemy aliens
   a. Japanese rehabilitation problems
      1) Urban
      2) Rural

SOCIAL AND ECONOMIC FACTORS AFFECTING HAY, WASHINGTON

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Those interested in history never tire of visiting historic spots and seeing items of interest that mean so much in the development of the Great West, and at the present time we are witnessing an awakening in the history of our own region, especially of our own state. I attribute no little amount of this to the work being carried on by the history teachers in this field of the various colleges of the Inland Empire. Certainly those students who have been fortunate enough to listen to Dr. Herman Deutsch, of Washington State, and have completed his course of the same name, cannot fail to have a more appreciative understanding of the Pacific Northwest. This course has had that effect upon this writer and many others with whom he has come in contact during his brief career as a teacher in this state.

It is so common for many of us to wish to make a study of some area, personality, or place, that is already quite well known, and thus many interesting incidents or places are passed over. This person soon discovered that he was living in a village which was significant because of its obscurity, not only in other counties, but by business men and other laymen right in my own county of Whitman. Furthermore, it is not my wish to embarrass those present from the eastern part of this state by asking them to locate Hay, Washington. Yes, you are right—it is in the southwestern part of Whitman County some thirty-five miles southwest of Colfax, and fourteen miles south of Lacrosse. A like distance from Texas City or Junction City if you are acquainted with those two historic spots.

My interest in this little village became quite acute shortly after assuming the duties as superintendent of its schools in 1939. This never abated during the two years I served in that capacity, and it was given a new life when an offer came to do some graduate work in local history for the Social ate work in local history for the State College of Washingtoon.

In attacking the study the first task of course was to determine just what area was to be included; this proved to be fairly easy through the interviews which had been previously arranged, with several of the early reputable pioneers of that section of the country. These interviews proved to be so valuable and so interesting that several of them were written up quite thoroughly, duly signed by the narrators, bound, and placed in the Library of the State College, and used as one of the basic references for the study.

Numerous leads were given in these interviews that were followed up in the old files of the local papers: the Lacrosse Clipper and Colfax Gazette. Your speaker found very little difficulty in getting these pioneers to relate their experiences, in fact he had some trouble in getting them to leave out some incident that was of interest to them but had little bearing on the subject at hand.

These two sources, pioneers and papers, were the chief ones used for the completed study, however County Office Files, old Atlasses, general works, and minor surveys were used to a good advantage. Also it was found necessary to drive more than 2500 miles around over the area to check some facts and conditions that were read or learned of through various sources. The sermons listened to in the Lutheran Church proved to be an interesting source for the account relative to the Norwegian Settlement found in that area.

It may interest you to know that: one of the parties interviewed gave me information that is not to be made public until 1951; that one was an employee of Bradstreet's for many years,

but upon visiting Hay in the early part of the 20th Century decided that here was the place for him to make his fortune—his judgment was correct; that another boasted over the fact that his father helped defeat Chief Joseph, the cause for which perhaps needs strong defense, and that another received her certificate of appointment as the first postmistress of Hay direct from President Cleveland.

So one might go on with the background of this study, but perhaps some of the findings will be more acceptable. One soon finds that the population of this area is composed of two major groups: Those from the Piedmont Belt and adjacent region to the west; they are spoken of as "Tarheels," regardless of the state of nativity; the other group of course is the Norwegians who came up from California, from the Great Lakes Region, or from the Old Country. The migration of this latter class covers about two decades and was completed in the early twenties, while some of those from the Atlantic region were out here shortly after the close of the Civil War.

We find that there are about 175 Norwegians living in a well defined locality not intermixed with the other inhabitants of that community. These people like to let you know that they have not had a single member of their group convicted of felony and only one has ever been arrested for any crime—the one exception being for having too many spirits within. The "Tarheels" also have a very fine record in this respect but not to be compared with the former. In visiting with the Carolinians one will find those who like to tell of the horse rustlers that lived in their midst in the early days and how the **Vigilantes** worked. Rumor has it that one would not have to look far even today to find some of the remains of this old gang—of course the profession ceased to be lucrative long ago.

Of more interest however is the fact that 75 per cent of the youth of the Norwegians remain in the community. This means that the farms are absorbing most of the population increase. Fifty-three per cent of the other group likewise stay at home, but the tendency of today, 1940-1941, is for the youth to leave and enjoy the high wages found in the defense industries. Whether they return or not, remains to be seen but no doubt will be a factor in changing the social pattern of the community.

The most surprising fact that this party discovered relative to the population was the very few marriages between these two peoples. There have been but four or five consummated; two occurred during the past two years. Thus it requires little stretch of the imagination to understand the interrelationship that of necessity must exist. Now this does not imply that these people do not mingle or associate with each other. On the contrary they attend the same schools, entertainments, visitation between a "Tarheel" and Norwegian family. It will be interesting to observe ho wlong this condition will continue because members of the Scandinavian group are viewed as prize catches by many of the other.

This community was served at one time by several small trade centers but Hay is the only one that remains today. Three thriving little hamlets ceased to exist some years ago when the main line of the railroad was shifted farther west and a modern highway was put through. Riparia at one time was a terminal for both railroads and navigation lines but today there is not a store of any kind to be found there—not even a gasoline pump. A warehouse marks the spot where Pampa once thrived, and Canyon is no more, while Central Ferry, or Bridge as it is called today, does serve the tourists who pause for a few minutes to view the mighty Snake. Hay has been more fortunate in that no highway has molested it, however train service is just a skeleton of what it once was. Furthermore, indications are that it will continue to exist as a trade center for years to come but in a much minor capacity.

Its continued existance can be attributed to its being so far removed

from larger centers and the poor connections it has had with the outside world up until the past two years. Its life is being threatened now from two angles—better roads—and the loss of its school through the Reorganization Program. However it is very doubtful if the general store, repair shop, and two or three units will be forced to move out or close down for several years, because this area is such a secluded rural community that it will require many of the foreging services—at prices which will warrant their remaining.

The village churches are decidedly on the decline but the Pentecostal which is a militantly Evangelistic group yet has a strong hold on the community activities, including such events as school programs and competitive athletics. There are those who adhere to the belief that their children cannot participate in any program where a costume is required, regardless of how simple it may be, even to a decoration in the hair or jewelry of any kind, furthermore taking a shower bath with other students is forbidden—a belief that works a hardship on those who need to, or want to, take part in physical education classes during the day.

The Lutheran Church which is located some six miles from Hay is one of the finest in the state and ranked as the best east of the Cascades. The membership is increasing at a fair rate and the Sunday School is growing very rapidly; it is one of the most active organizations that it has been my privilege to became acquainted with. Perhaps this group would enjoy knowing that the members of this church support their minister so liberally that they furnish him a lovely parsonage in Lacrosse, a salary of $1740 per year and just recently they gave him a new Buick for a Christmas present. Yes, these farmer folk are quite well fixed in a worldly sense and not a one of them has made a failure of his undertakings so far in the history of the settlement, but some few have had to struggle to stay on top.

The value of farm equipment has increased quite rapidly during the period surveyed, an indication that they are trying to enjoy some of the comforts of life as well as to conserve human resources. This is a commendable practice if not carried to the extent to jeopardize one's economic position.. A survey made of the farms lost because of this revealed that relatively few have lost their places because of living beyond their income.

One cannot help observing the number of new cars and other improvements that are very much in evidence. Especially has this been true during the time of the Federal Allotment Program. There are many farmers that trade for a new car each fall, and few there are who do not have a pick-up and truck in addition to the family car.

Another development which is becoming very pronounced is the change from the production of wheat to a combination of livestock and grain growing. The farmers have discovered that the marginal land, broken up when wheat commanded a good price, is now more valuable for other purposes and, further, that it is a good policy to market some of the grain on foot. This movement is of very recent origin and is gaining in popularity; perhaps the experiment being carried on by the Federal Soil Conservation Office on the R. D. Smith farm is a strong factor in promoting the change because of the success and advantages such a program has demonstrated.

The McGregor ranch is the outstanding one in this entire area. Its history goes back to the days when this state was but a territory, and, it has seen a constant growth until today it includes some 33,000 acres. It is not known just how many acres have been sold recently to farmers, but the acreage is considerable if one accepts the statements made by farmers that have purchased land from this family.

Many of us look back upon the year of 1932 as the darkest of the depression years, but at that time this ranch was feeding 25,000 to 30,000 hogs and 5,000

lambs, which were produecd right at home. The wheat for all this livestock was stored in their 65,000 bushel elevator and in the steel tanks on the ranch which more than held the balance of the 100,000 bushels produced annually.

Their thrashing crew consists of three gangs of equal size in order to make for more efficient work; in addition to these three crews they are required to maintain three camps of twenty men each to care for the sheep during the year, therefore, it is readily seen that to operate this large ranch requires no little work and planning on the part of the present manager, Maurice McGregor.

For a number of years, the farmers of this community had been without any type of cooperative program; but of recent years the Grange and other related groups have begun to function. The Grain Grower's Association is definitely an organization which works for the welfare of the farmers, both as a group and individually. One of the greatest services which this Association renders to the farmers is that of supplying them with ready cash during the weeks preceding harvest. One of the officers told me that it was not uncommon to let out as much as $80,000 each year to farmers in need of working capital. This organization does not wish to compete with the banks; but in many cases the banks are slow to make the loans, whereas the former is not afraid of the investment. The records show that not one dollar has been lost by this type of aid but many new members have been added because of this needed service and this year a nice dividend was declared for all the members.

The cooperative store in Dusty has been very instrumental in reducing the cost of gas and oil to the farmer and has paid him dividends on his purchases through the general store, and is also making for a uniformity in the growing of grain and livestock of that area.

There is little reason to believe that the river transportation will become a factor of much weight within the near future. A rather extensive survey carried on by the speaker during the past year gave no indications that the Snake River would be the scene of the inicdents reminiscent of earlier days. The big drawbridge which spans the River at Riparia has had to open but twice during the past year to permit the passage of a barge up the river and its return a few days later—but many elevators are being constructed, or have been erected, during this same time along the railroads to permit the moving of grain by the iron horse.

In trying to summarize this paper may I state that family life in Hay will continue stable for many years to come because the majority of the people are exceptionally conservative in their belief and view divorce in an unfavorable light. There is not a single divorce or divorcee in the community, although one family did move away and later separated, but it is no longer considered a member of the locality.

With the passing of the schools, fewer trading centers, and the consolidation of the farms, the people can look forward to a diminishing amount of wholesome recreation for the remaining number.

Just how long the land can absorb the younger generations as it has been doing remains a moot question. It is a well established fact that the youth of this community are remaining on the farms of an ever increasing acreage. This condition is balanced by a lower birth-rate, but here one must consider the conditions which the present composite population has created, namely, the major portion being the middle-aged group, which has a very low death rate. Modern transportation and the desire for a different type of entertainment than that found at home may be the factors that will cause the younger people to seek their future elsewhere. This belief is supported to some extent by the wider outlook found among the young couples and their discussions of

the shortcomings of the local community.

I should not care to leave you with too pessimistic a picture with this rather brief discussion of a local area of our state. We all agree that this century has brought the farmer much that history will call progress. His horizon has been enlarged until he is seeing and operating larger farms, and is visiting larger and more modern retail stores. The farmer of Hay and community is able to give his wife and children advantages such as no farmer in history could ever dream of providing. He is rightfully sharing in the luxuries that a highly effective machine culture has provided. He is remaking his life and is becoming adjusted to a new world which he undoubtedly finds more stimulating, interesting, and worth while than his forefathers found it to be.

Certainly this urbanization that we are experiencing marks a major turning point in the cultural and social history of mankind. True, it has left the farmers, as well as the city man, with many adjustments to make. But have we ever had a perfect civilization? No. Certainly much that is ideal has been achieved in given phases of our farm life, and this applies to the little community in southwestern Whitman County. Our youth or farmers of Hay may readily escape from an environment that they dislike and find room elsewhere to develop the talents or special interests that they may have.

For the people within the little hamlet of Hay: They have the poor comfort of knowing that their lot is not solitary; there are many facing the same future. They read and hear of factories leaving the cities but likewise they know that such is not for them because the suburban areas secure such enterprises.

PRELIMINARY REPORT OF GEOLOGY ALONG PART OF TUCANNON RIVER

MARSHALL T. HUNTTING
State College of Washington

For many years there have been recurring notices of mining and prospecting in the Blue Mountains in Washington, but activity there seemed to be sporadic and of little economic importance. No extended geologic study of the area had been recorded; consequently, in 1936 when the Preliminary Geologic Map[1] of the state was published the pre-basalt rocks of the Blue Mountain region were insufficiently known to permit their being mapped. However, three areas of pre-basalt rocks outside of the Blue Mountains but within the four southeastern counties were mapped at that time. One area of about 20 square miles east of Johnson, mapped as Mesozoic intrusive, included Bald Butte Ridge called by Hoffman[2] a stock of the Idaho Batholith. Ten miles west of Johnson in the Snake River canyon at Granite Point a small patch of granitics was also mapped as Mesozoic intrusive. In the third area, comprising a small tract just south of the junction of Grande Ronde and Snake Rivers and a second tract 5 miles north of that junction, greenstone and limestone were mapped as Carboniferous in conformity with mapping on the Idaho side of the river.

Other exposures of pre-basalt rocks were known, and the existence of still others was suspected. Among these is the exposure recently reported by Baldwin[3] in eastern Columbia County in the valley of the Tucannon, a tributary to Snake River. The lithologic and stratigraphic relations of these and other rocks already mapped are now being studied in connection with economic investigations in the area.

The exposures along Tucannon River have been developed by the river's deep erosion through the thick basalt cover overlying the pre-basalt land surface. According to Russell[4] Tucannon River is a consequent stream on the upwarped basalt flows. In eastern Columbia County the river flows northerly and falls at the rate of about 85 feet per mile, which is approximately the direction and degree of dip of the Columbia River basalt flows through which it cuts. The northward dip of the flows probably is the result of post-basalt uplift in the Blue Mountains immediately to the south. The Tucannon and other rivers with their tributaries have completely dissected the uplifted basalt plateau leaving interstream ridges of fairly uniform heights. The relief from river level to ridge tops averages 2000 feet, river level at Tucannon Forest Guard Station being 2600 feet above tide. Slopes are steep and are moderately forested with pine. Underbrush is not thick and unforested areas, in most cases south slopes, are grass covered.

Of the two pre-basalt rock exposures studied to date one is largely within section 15, T. 9 N., R. 41 E. on both sides of Tucannon River which here flows approximately N30°E. This exposure is nearly pear-shaped, with 1½ miles length and 1 mile maximum width. The stream lies to the southwest, up stream on the Tucannon, which bisects the pear longitudinally. A maximum elevation, 3600 feet above tide, in the exposed pre-basalt rocks is reached at the easternmost point of the exposure, at the basalt contact. The rocks of this exposure have a total relief of 1300 feet.

The second exposure is 1½ miles north of the other in section 3 and entirely on the west side of the river. It is ½ mile long by 600 feet wide, and has a relief of 300 feet.

The locations of at least four other exposures in the area are known, but they have not yet been visited. Near the head of Cummings Creek, a tributary to Tucannon River, is an occurrence of granitic rock, and pre-basalt rocks are known to outcrop along

Panjab and Sheep Creeks, other tributaries about 8 and 10 miles respectively upstream from Cummings Creek. Pre-basalt rocks are reported[5] about 35 miles down the Tucannon near Starbuck.

The scattered distribution and small size of exposures, together with the great relief in the pre-basalt rocks of some exposures, points to a rugged mountainous pre-basalt topography, only the highest points of which are now exposed by erosion.

Discontinuity and scarcity of outcrops in many places, coupled with the massive character of many of the strata, make structure and stratigraphic determinations somewhat less secure than could be wished. However, outcrops and mine workings in the eastern half of the pear-shaped exposure indicate a succession, from bottom to top, of several massive and laminated black and gray chert and massive black argillite beds about 25 feet thick interbedded with greenstones of about the same thickness, overlain by several hundred feet of black and gray cherts, black and olive argillites, and light colored argillites and cherts. Across the river in the southern portion of the exposure essentially the same succession of strata is found. In all these strata a regional trend N60°E is generally maintained. On the east side of the river dips, predominantly to the southeast ,range from 70°SE to 80°NW, but on the west side the dips, also in both directions, are predominantly steep to the northwest. This reversal of dip, coupled with the similar succession of strata both eastward and westward from the river, suggests a sharp, nearly closed anticlinal fold the axis of which lies partially in and nearly parallel to Tucannon River valley. Unless there is unrecognized repetition of strata by folding or faulting, a stratigraphic thickness of more than 1000 feet has been exposed.

The rocks of the northern portion of the eastern half are lithologically different from those in the remainder of the pear-shaped exposure. Of the northern rocks the lowest stratigraphically are hard, massive, greenish and grayish sandstones striking generally N30°W and dipping 50°NE. The sandstone, at least 300 feet thick and possibly much thicker, is overlain by several hundred feet of greenstone. The lithologic and structural differences between these and the rocks to the south are the basis for the postulation of an unconformity between the two. In the absence of better evidence the lower dips, less shearing, and slightly less induration of the northern rocks are taken to indicate their younger age.

The smaller exposure in section 3 is made up of dark green foliated rocks. The foliation strikes in general N55°W and dips 50°NE, which is almost parallel to the bedding in the sandstone in the northern portion of the exposure to the south. The rocks of the northern exposure have been insufficiently studied to make clear their relations to the others, but the suggestion is that they are of sedimentary origin and a part of the younger series.

WORKS TO WHICH REFERENCE IS MADE

[1] Preliminary Geologic Map of Washington, to accompany Bull. 32, Wash. Division of Geol., 1936.

[2] Hoffman, M. B., The geology of Bald Butte Ridge, Washington, Jour. Geol., Vol. 40. pp. 634-650, 1932.

[3] Baldwin. E. M., in written communication to H. E. Culver, Nov., 1939..

[4] Russell, I. C., A reconnoisance in southeastern Washington, U. S. Geol. Survey, Water Supply Paper 4, p. 23, 1897.

[5] Long, T. B., in personal communication.

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Vol. XVII No. 1

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The Northwest Scientific Association

Single Copies Thirty-five Cents

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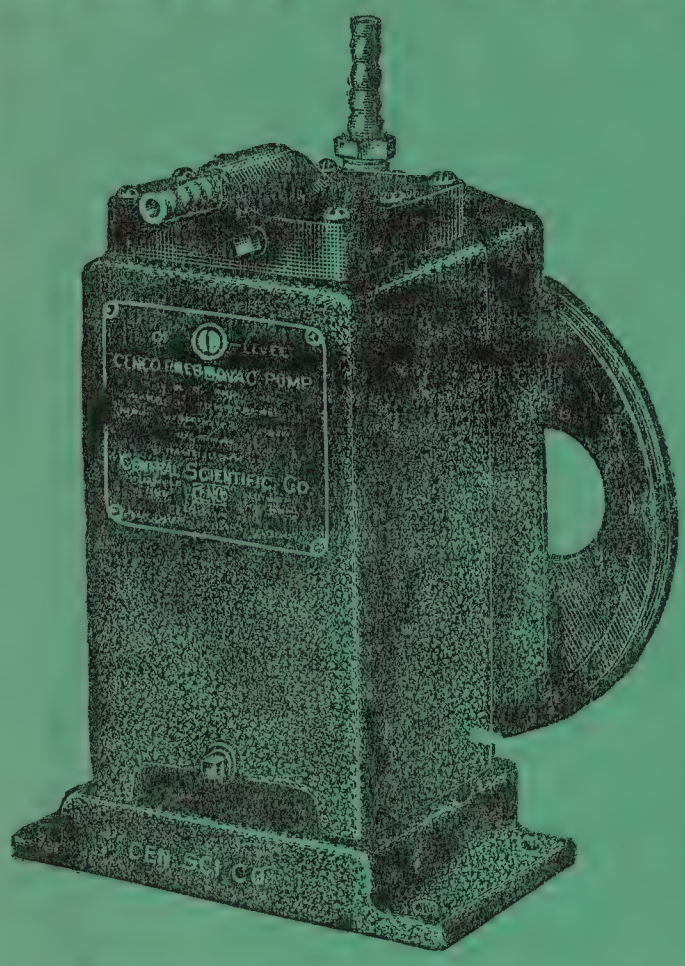

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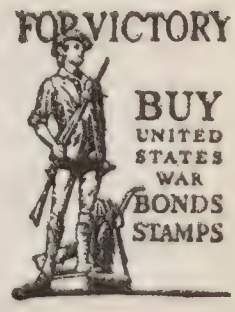

RESEARCH GRANTS

Prof. H. F. Raup, Sec.-Treas., N. W. Scientific Association December 1, 1942

Dear Prof. Raup:

In response to your circular letter of October 10, I am enclosing a dollar bill to cover my dues for 1943.

Although your letter appealed for donations to the Association research funds "in order to continue present research projects', and although I have contributed regularly in the past, I am offering an idea instead of a dollar or two this time.

Briefly, frankly, and perhaps brutally, the very minor research projects toward which our Association has made annual contributions of $25 to $50 have never produced very much. From the standpoint of new knowledge obtained I doubt that our "investments" have paid dividends equal to the average of mining stocks,, which are notorious gambles. Our Association might be accused of being a bum gambler.

On the other hand, part of our investment has been intended, I suppose, to encourage promising and hard-struggling research workers. I seriously doubt, however, that the picayunish grants-in-aid, which are the best we have been able to make, have turned the tide or tipped the financial scales for a single one of the recipients.

I hope that I am wrong on both of these points, but I suggest that we now look at our record from this angle and either commend ourselves for our achievements or decide to search for some better use of our so-called "research funds." If it is decided to make such a search, I have a suggestion: Why not set up certain funds from which specified awards—either cash or medals or frameable citations on parchment—will be made upon Association recognition of RESULTS ALREADY OBTAINED? Any such "posthumous" moneys might be welcomed to pay bills incurred during the research, or to carry on. Mere citations, if awarded in accordance with severe yet attainable criteria, certainly would be cherished by most any of us. Every Section of our Association ought to be able to raise funds to pay periodically for a framed parchment citation. Some Sections already have adequate funds.

There are two other features of this idea which deserve consideration. First: If the objective is to encourage productive research, the mere specification of beneficial research results might aid many research workers more than money would do. This may be slander, but a lot of so-called "research workers" think they have made a contribution if they merely work on their "project" for a few years. Our Association might help by stressing the falsity of that belief. Second: There are numerous "Awards" being made now, of the type which I suggest. There is the John M. Goodell cash prize award by "Engineering News Record" for the outstanding paper given before the American Water Works Association. There is the Hillebrand prize of the Chemical Society of Washington,, D. C. There is the Willard Gibbs medal awarded by the Chicago Section of the American Chemical Society; the Wollaston, Murchison,, Lyell, Prestwich and Bizsby medals of the London Geological Society, and the Charles P. Daly Gold Medal of the American Geographical Society. There are also, of course, the grants-in-aid by the National Research Council and various endowed Foundations. The former medals, etc., are obviously intended to serve as recognition of good work; the grants-in-aid are intended to help finance it. There is a vast difference, and most of the societies apparently recognize the fact that if funds are limited, best encouragement to research is obtained by awarding prizes or medals on the basis of the character of work completed.

Hence, I suggest that in view of our decidedly limited Northwest Scientific Association funds the Councilors and Trustees might consider the possibility of changing from our past practice of picayunish grants-in-aid, to one of awarding citations, medals, or prizes.

Very sincerely yours, H. T. GISBORNE, Trustee.

-:- NORTHWEST SCIENCE -:-

Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes I to XVI, 1927 to 1942, each $1.25
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VOL. XVII, NO. 1. **FEBRUARY, 1943**

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CORVALLIS MEETING A. A. A. S.

Several inquiries have been received of late as to whether or not the Executive Committee of the Pacific Division, A.A.A.S., and the Local Committee propose to proceed with plans for the meeting in Corvallis in June, 14-19, 1943. As yet, we have had no advice from the Office of Defense Transportation to the effect that summer meetings should be cancelled. We assume that the cancellations of which we have heard of late have arisen due to the unusually heavy burden thrown upon rail facilities during the Christmas season. It is our assumption that the problem will be less grave in June. We shall, however, keep in touch with the Office of Defense Transportation, and should it be necessary to revise present arrangements, we shall notify you promptly.

This, therefore, is merely an explanatory note to assure you that as far as we know now, the meeting at Corvallis will be held in accordance with present plans.

Copies of this letter have been sent to all Associated and Affiliated Societies and Members of the Council, Pacific Division, A.A.A.S., including the Northwest Scientific Association. Sincerely yours,

Stanford University, California J. MURRAY LUCK, Secretary

The editor would welcome short communications from members regarding points raised by Mr. H. T. Gisborne in his letter. Possibly several of these may be published in the next issue of Northwest Science.

One of the papers in this issue, by O. Redlick and L. F. Maranville gives the results of a research grant-in-aid from the Northwest Scientific Association.

If Northwest Science is to continue to be published the members must cooperate by sending in papers for publication. Usually enough papers are turned in at the annual meeting to fill the magazine for the ensuing year. At present the editor lacks enough articles to fill the May issue and earnestly requests that members submit their manuscripts to him for publication.

An index for volume 16 of Northwest Science for 1942 has been issued and will be mailed gratis by us to any member or subscriber who requests it from the editor.

MAR 25 1948

IONIZATION CONSTANTS OF SULFANILAMIDE

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A report on research supported by a grant-in-aid from the Northwest Scientific Association. This paper was read on Dec. 30, 1941, at the annual meeting of the organization.

At the meeting of Northwest Scientific Association on December 28, 1940, we had an opportunity to propose a partial explanation of the connection between therapeutic activity and chemical structure of sulfanilamide and its derivatives. The facts to be explained were: (1) The importance of the amino group. Substitution of the amino hydrogens regularly destroys the activity and several authors have shown that this group probably is oxidized in the body. (2) Substituents which are far distant from the amino group affect the activity in a way which depends not only on the nature of the substituent, but even on its position. The difficulties of an explanation of this fact have been pointed out by Northey.[1]

There is only one way in which "remote control" is transmitted through a large molecule: by loosely bound electrons, i. e., electrons which are not so tightly attached to a certain atom or bond as electrons usually are. Molecules with loosely bound electrons cannot be represented by the means of the classical valence theory. However, they may be considered as hybrids of two or more classical structures ("quantum mechanical resonance").

As the loosely bound electrons are particularly apt to transmit *electric* influences, we shall expect some relationship between the *electrical* character of remote substituents and the therapeutic activity of the derivitives. Indeed, the results of Roblin and Winnek[2] give striking evidence of a relationship of this sort (cf. Table 1).

In order to characterize the electrical character of a substituent X we can make use of the dipole moment μ. of Hammett's quantity σ (sigma) or some similar property.[3]

Table 1

Therapeutic activity and electric character of the substituent of 5-sulfanilamido-2-X-pyridines and 2-sulfanilamido-5-X-pyridines.

Substituent X	Therapeutic activity 2-S-5-X	5-S-2-X	μ 10.[18] of C_6H_5X
NH_2	+	—	+1.5
OC_2H_5		—	+1.2
H	+	+	0
Cl		+	-1.5
Br	—	+	-1.5
I	—	+	-1.3

Shortly after we had presented this suggestion before the 1940 meeting of this Association, Halverstadt and Kumler[4] published a note in which the same basic idea was advocated, though without a discussion of the data assembled in Table 1. Later the same authors[5] tested and confirmed the assumption of resonance by measuring dipole moments.

As pointed out a year ago, several methods could be used to test our assumption and to make predictions later as to the probable activity of unknown compounds. Besides dipole moments, there are atomic distances, ultraviolet absorption spectra, heat of combustion and other properties which give information of resonance.

The most direct and promising way appeared to be the determination of ionization constants. The deviation from the structure given by the usual formula results from resonance with quinoid forms in which the amino and the sulfamido group carry electric charges. These charges counteract ionization so

1. E. H. Northey, Chem. Rev., 27, 85 (1940)
2. R. O. Rob'in, Jr. and M. S. Winnek, J. A. C. S. 62, 1389 (1940).
3. L. P. Hammett, "Physical Organic Chemistry" McGraw-Hill Book Co., New York, 1940 (Chapter VII).
4. I. F, Halverstadt, W. D. Kumler, J. A. C. S., 63, 624 (1941).
5. W. D. Kumler, I. F. Halverstadt, J. A. C. S., 63, 2182 (1941).

that the ionization constants should be smaller than in corresponding non-resonating compounds.

The experimental difficulties of determining the ionization constants of slightly soluble, very weak electrolytes are considerable. Only a potentiometric method can be applied. We are using a cell consisting of two hydrogen electrodes, one in hydrochloric acid, the other in a solution of sulfanilamide in acid. The two flasks are connected by a KCl-agar bridge. Using microburettes, we add carbon dioxide-free sodium hydroxide solution first to the first, then to the second flask, determining the electromotive force by means of a precise potentiometer and sensitive mirrorgalvanometer.

From the results of these determinations we find the pairs of acid and acid-sulfanilamide solutions which have equal hydrogen ion concentration. The composition of these solutions furnishes the data from which the ionization constants can be calculated.

This method diminishes and practically eliminates most of the uncertainties and sources of error usually connected with potentiometric titration methods.

So far our measurements on sulfanilamide have been finished. This substance is not only a base (ionization constant $K_1 = 1^{\circ}1.10^{-12}$) but also an acid ($K_2 = 2.10^{-11}$). It is interesting that the acidic ionization, obviously originating in the amido group, is even appreciably stronger than the basic ionization, to be localized in the amino group. As far as we know, the acidic ionization of a sulfamido group has been previously observed only indirectly, namely by the solubility of primary and secondary (not tertiary) sulfamides in strong bases.

Determinations on related substances are being carried out.

THE NORTHWEST REGIONAL COUNCIL AND REGIONAL DEVELOPMENT

JOHN B. APPLETON, DIRECTOR

NATURE AND OBJECTIVES OF THE COUNCIL

The Northwest Regional Council is a non-profit organization composed of governmental, civic, business, and educational leaders in the Pacific Northwest. It is financed by the Rockefeller Foundation, has its own staff and Board of Trustees, and is free from political and financial influences of special interest groups. It can, therefore, go about its work impartially and objectively.

Its major aims are to foster public understanding of the nature and importance of problems involved in the wise use of the region's resources, to encourage continued research on these matters, to aid in coordinating the established research efforts of the many public and private agencies functioning within the region, and to encourage the study of the region and its problems in the public schools and institutions of higher learning. No similar organization exists in any other part of the country. In the present emergency considerable thought is being given to post-war problems.

When the Northwest Regional Council came into being in 1938, many public and private agencies were already working on problems of resource management and planning. A great deal of important data had been collected and many technical bulletins prepared. The circulation of this information, however, was confined almost entirely to those working on the problems. Satisfactory methods had not been devised to bring this research and the potential benefits to be derived from it to the attention of the public in a way to stimulate public awareness of regional affairs. Furthermore, there were frequent duplication of effort and lack of coordination between the agencies engaged in research, largely because there was no central clearing house to show what was being done and what was lacking. These weaknesses were felt keenly by a number of people interested in promoting the general welfare of the region and through their efforts the Northwest Regional Council was established.

Promoting Public Understanding

Reporting Research

Public understanding is necessary to the success of all work designed to promote regional development, but this can be achieved only if and when the average citizen has the information which will enable him to react intelligently. The need is urgent for the widest possible dissemination of information regarding problems that confront the region.

Effective reporting of research is vital. This takes two principal forms—technical and non-technical. The former is essential to the specialist desirous of keeping up with new developments in his specific field, or to give direction to new research. The latter should be designed to meet the needs of the general reader who wishes to be adequately informed. The layman is interested in results. Usually his technical background is limited. He prefers brief non-technical explanations and directions presented in an interesting, stimulating fashion. Long, tedious discussions discourage all but the most persistent seeker after truth. In order to encourage a greater interest in research and its findings among as large a number of readers as possible, the Council has issued several types of books and bulletins at various educational levels. Prior to publication, all manuscripts are checked by experts for accuracy and readability.

During 1939 more than sixty technicians and consultants collaborated in a survey under the direction of the Pacific Northwest Regional Planning Commission to determine more exactly the economic possibilities of the region.

This culminated in a single lengthy report, "Migration and the Development of Economic Opportunity in the Pacific Northwest." This was available only in a limited mimeographed edition. To remedy this situation and to reach a wider reading public, the Council had this report condensed and rewritten in a non-technical, interesting style and published it under the title "Men and Resources." This concise version of the original report has had a wide circulation not only among the general public but also in the schools and colleges in many parts of the country.

Frequently several agencies prepare independent reports upon a particular problem. Unless this scattered information can be brought together and made more readily available in reasonably small compass, it is rarely effectively used. For example, much research during the late 1930's was devoted to the migration problem in the Northwest. A number of books as well as technical reports were written recording the results. Here was a problem of vital concern to young and old, to the college student and to the child in the public school. The Council staff used this material for two publications. A summary of these reports at the college level was written for the Geographical Review under the title of "Migration and the Development of Economic Opportunity in the Pacific Northwest." The same reports were the basis for "Caravans to the Northwest," a high school text which dramatically portrayed the migration problem by word, picture, and color.

Much important technical information becomes far more usable when presented in the form of well executed accurate maps. Space and locational relationships are immediately apparent. Statistics become more meaningful. Inter-relationships between man and his environment can be readily visualized —relationships which are essential to the understanding of many community, state regional, and national problems. The Council undertook the task of initiating and coordinating the joint effort necessary to produce an "Economic Atlas of the Pacific Northwest." This atlas, which covers the principal physical, social, and economic aspects of the region, brought together in graphic form important research of several federal agencies. A non-technical interpretation accompanies each map and numerous cross references serve to guide the reader in making effective use of the Atlas. Although it was designed primarily for use in the public schools, it is having a wide circulation among business and industrial organizations all over the country.

"The Pacific Northwest - A Regional, Human, and Economic Survey of Resources and Development' is another example of cooperative effort involving both federal employees and educators which was facilitated by the Council. By coordinating the efforts of some thirty authors, all specialists in their particular fields, a really comprehensive regional geography of the Pacific Northwest has been made available.

Promoting Regional Study in the Public Schools

From the time the average adult leaves school, he or she is primarily concerned with the problems associated with making a living or the management of a home. Few have the time or the inclination to give much thought to the affairs of the region in which they live. Yet their economic security, their economic opportunities are dependent upon the management of the resources in the region. Too many take these resources for granted—often until it is too late, until drastic readjustments in their way of life are necessary.

The Council has taken the position that a major function of education is to prepare students for the realities they will face when they emerge into the work-a-day world. Many of the students in the Pacific Northwest expect to make their homes in the region permanently. Consequently, a vital part of their education should be directed toward giving them an understanding of the region, of the problems that confront it which they will be called upon

to meet, of the opportunities that exist, of the measures that are necessary to promote optimum economic well-being, and the means by which desirable changes may be instituted through democratic processes. Only through an intelligent understanding of these things are they likely to become active participants in local, state, and regional affairs. Interest created in the school through effective study of local and regional problems may well result in active leadership in the solution of such problems in later years.

To achieve these ends the Council has taken an active interest in curriculum development, in the preparation of educational materials adapted to school use, and in the training of teachers to handle resource problems effectively in the classroom.

Obviously, the first requisite to foster this phase of education is the provision of materials for teacher and student use. As a first step in this direction, the Council issued its "Know Your Northwest Series." These books were intended to serve as a guide to a systematic study of the principal resources and resource problems, to provide a carefully selected bibliography of source material suited to teacher and student use, to highlight the principal facts and problems that should be given consideration, and to indicate the chief agencies, public and private, to which teachers could turn for technical help.

Two issues in this series, "Soil Conservation" and "Forest Depletion," were devoted to detailed analyses of particular problems. Another described how the Seattle school system had incorporated regional resource study into its curriculum. All were intended to develop background for classroom units of study.

There is an urgent need for classroom material which can be put in the hands of every student. To this end "Your Oregon—Yesterday, Today, and Tomorrow," by John B. Woods and Nelson S. Rogers, was prepared as a text for the eighth grade under the auspices of the Council. This book is designed to show the bases upon which Oregon's economy has been built from early exploration and fur trading days down to the present time, and the importance of conservation to the maintenance of the prosperity of the state. "Caravans to the Northwest" and the "Economic Atlas of the Pacific Northwest" are intended to serve a similar purpose.

Since many teachers lack background in the type of work involved in the study of regional problems, two forms of training were devised. Short professional courses in which teachers enrolled on a voluntary basis were organized in the principal urban centers under the aegis of the local education authority. These courses consisted of a coordinated series of lecture forums at which experts in particular fields presented the subject matter and major problems relating to their specialties.

The second device was the "Pacific Northwest Resources and Education Workshop." With financial assistance from the U. S. Commission on Resources and Education, the Council organized the first of these in the summer of 1940 at Reed College and the University of Washington. For a period of five weeks a carefully selected group of teachers worked with a staff of resources and educational experts in conference seminars. This technique permitted resource experts to present the basic facts and problems concerning forestry, fisheries, minerals, land, water, power, industry, population, and planning; and educational consultants to determine in conjunction with teachers how best the subject matter could be used in the schools. Since then similar Workshops have been organized each year by the University of Washington with very gratifying results.

Concurrently with its publication and teacher training program the Council staff has participated in conferences and meetings sponsored by the various scientific, professional, and educational organizations throughout the region.

Through such contacts it has been possible to advocate the ideals for which the Council stands, to discuss significant regional problems, and to inform an important segment of the population of what is being done to promote regional well being. Through membership on numerous committees, both scientific and civic, it has been possible to have a part in the formulation of policies and in the activities of a number of important state and regional organizations.

So far the surface has hardly been scratched, but enough has been done to give various techniques a trial and to discover public reaction to these methods of disseminating the results of research. It has been proved beyond a shadow of doubt that an agency such as the Council is in a strategic position to develop a constructive program for promoting public understanding on regional affairs.

STIMULATION OF RESEARCH

Council Sponsored Research

Research provides the information necessary to the solution of regional problems. Through it a more effective use of natural and human resources is possible; new or improved techniques of management, production, and distribution are developed.

A specific portion of Council funds has been earmarked to aid in the prosecution of this phase of its program. Numerous grants-in-aid have been made to individuals or groups of individuals to undertake particular jobs that have regional implications. In some instances the projects have been defined by the Council; in others they are the results of individual initiative. Such grants have been made only after a careful review of the project, of the need for the particular study, and of the personnel involved.

As an initial step in this phase of its work, the Council undertook the preparation of a bibliography of completed and in-progress research in the physical and human resources field. "The Pacific Northwest—A Selected Bibliography." This was intended to show the more important research that had been completed between 1930 and 1939, and the general trend of research under way. This survey showed that productive research is more active in the physical than the human resources field, that there is a noticeable dearth of urban and industrial studies, and that much of the work done is highly specialized or local in application. This bibliography should offer bases for more complete integration of future work on regional problems, and prevent needless duplication of effort. It has proved to be a valuable source of information to educators as well as to researchers.

In its efforts to encourage research, the Council has established close working relationships with public and private agencies and scientific organizations engaged in this type of work. This was done to facilitate the exchange of ideas, to eliminate duplication of effort, to discover specific projects which the Council is strategically fitted to undertake or sponsor, and to enable the Council to function more effectively as a clearing house of information.

With these ends in view, a cooperative agreement was worked out with the Pacific Northwest Regional Planning Commission and the Bonneville Power Administration regarding research to be done in the economic field. Each agency has, in consultation with the others, carried on or sponsored the research it is best equipped to handle, and several important studies have been completed and published. Among these are "External Trade of the Pacific Northwest" and "Taxation of Industrial Corporations in Washington and Oregon" by the Pacific Northwest Regional Planning Commission; and "Industrial Site Surveys" by the Bonneville Power Administration.

For its part the Council initiated a study of labor relations — a problem which only an independent, impartial organization can properly undertake. This problem was selected because many people, particularly eastern industrialists, felt that the labor situa-

tion in the Pacific Northwest was unsatisfactory to the establishment of new manufacturing industries in the region. Two phases of this study have been completed and the results published.

The first study involved a statistical analysis of strikes in the region from 1927 to 1940. This assembled for the first time, in convenient, usable form, the best available information on the occurrence and causes of strikes and the data were carefully interpreted in the light of the best information available. The results show how the Pacific Northwest stands with respect to other regions of the country and refute the unfavorable opinion that has been widespread.

Since strikes are the normal consequence of industrial disputes, it was decided to investigate labor relations in a major industry—pulp and paper, in which no strikes have occurred since collective bargaining was instituted. It was felt that such a study would reveal relationships and techniques worthy of wider application. These relationships and techniques were examined in the industrial setting provided by this industry. The study, "Labor Relations in the Pulp and Paper Industry of the Pacific Northwest," shows what can be accomplished when good faith characterizes the relations of both employers and the unions in their mutual dealings.

A number of grants-in-aid of research have been made to the personnel of the various colleges and universities in the region to enable them to undertake and complete studies of restricted scope or segments of large regional projects.

A study sponsored by the Council is now under way by two members of the faculty of the University of Idaho School of Forestry—"Ecological Relationships of the Fungi in Western White Pine and Related Forest Associations." This technical research will provide information basic to the development of a sound management policy in this important forest type of the Northwest.

The Council made possible a cooperative study concerned with land management problems in Idaho. The Idaho State Planning Board was asked to undertake a comprehensive study of the lands in state ownership and to submit recommendations by which more effective management could be secured. Assured of active collaboration in the study by the various technical agencies concerned, the Planning Board approached the Council for financial assistance to secure the services of a director for the study. A grant-in-aid was made and the preliminary survey was completed. A summary of its findings was published by the Council under the title of "Management of State Owned Lands in Idaho."

At the present time the Puget Sound Regional Planning Commission is making an intensive study of the twelve counties adjacent to Puget Sound. Numerous agencies are involved in this major cooperative project. One segment of this work involves an analysis of the population pattern in the Puget Sound region in its environmental setting, 1900-1940. The Council has provided funds to aid a graduate student of the University of Washington to complete this particular part of the project.

The "Report on Some Legal Aspects of Farm Tenancy in Oregon and Washington" will serve as an illustration of a more specialized type of Council sponsored research. This study was made at the request of several federal agencies concerned with farm tenancy. It was considered a necessary first step to a comprehensive land-tenure study of the Pacific Northwest. The report sets forth in relatively non-technical language the existing statutes and legal decisions governing farm tenancy in Oregon and Washington. It indicates problems which have caused litigation in the past; discloses the present legal pitfalls; comments on the operation of the law; and makes suggestions for remedying the defects. The report was designed especially for use by the field personnel of the Farm Security Admin-

istration and other federal and state agencies concerned with the problem.

In the present period of social dislocation, the condition of the Indian population of the region is being materially affected. In the post-war period serious difficulties in rehabilitation are likely to occur. In order to determine present conditions and trends more accurately, a member of the University of Oregon faculty spent the past summer living on the Yakima reservation. This field experience was made possible by a grant-in-aid from the Council. A detailed report has been prepared which should provide basic information for those concerned with Indian affairs, both now and in the period following the war.

Formulation of a Coordinated Research Program with Special Reference to Post-War Reconstruction and Development.

With the coming of the war, the sights of planning agencies have been turned to focus on the necessary adjustments the nation must make now and at the termination of hostilities. The war is having strong impacts on the economy and the people of the Pacific Northwest — impacts which will increase in number and strength as the war goes on. They will raise problems of reconstruction, readjustment, and development which must be faced in the post-war period. Research takes on added significance.

Here again the Council, as a private, independent agency, can perform a needed task which might otherwise be difficult of accomplishment. There must be a definite research program for the region, to guide researchers in the selection of problems that are of immediate concern and which form parts of a coordinated pattern. Such a program has been outlined by the Council in consultation with leading authorities of the country. This has been submitted to the universities and colleges of the region for their consideration and suggestions. The program was based upon detailed suggestions of the National Resources Planning Board in an agenda for post-war planning. This memorandum is designed to acquaint faculty members with specific types of problems which confront the region and upon which research is urgently needed. The role that faculty members in the several institutions of higher learning may play is well demonstrated by what such scholars have done and are doing in the Columbia Basin Studies, and in the several projects now in progress under the direction of the various planning commissions and the National Resources Planning Board. Graduate students, under proper guidance, can also work upon segments of problems as seminar training and thesis topics.

The present proposals are intended to be tentative and suggestive rather than complete. They are built around eight major fields of interest: industry. land-use, minerals, urban studies, urban-rural problems, transportation, power, and population. Each offers a wide range of research problems the solution of which will provide much needed data for the use of those concerned with post-war planning programs.

Stimulation of Graduate Training Programs.

The Pacific Northwest has an economy dependent almost exclusively on agriculture and forests at the present time, with great developments of hydroelectric power under public auspices auguring important changes in the basic economic structure. Here is a great laboratory, within which properly integrated methods of resource management can be developed and the training of resource managers refined.

In speaking of the development of the Grand Coulee region, Lewis Mumford says, "The new resources that will be created in eastern Washington by the new dam demand an heroic order of public service, a generation disciplined to creative thinking and cooperative public action, a corps of architects, educators, poets, and philosophers, no less than farmers,

agricultural experts, and engineers. Do they exist in the Pacific Northwest except in minute samples? No. Do they exist even in the United States? Only a handful."

With these words, Lewis Mumford presents a challenge not merely to the Pacific Northwest, but to the entire nation. Have we the vision, training, and leadership to manage our resources so as to secure from them a permanent civilization in which that freedom of individual action, so distinctively a part of American life, can function within the framework of the social and technical discipline necessary for preservation of its physical base? Can we integrate our rapidly expanding scientific knowledge into a way of life which will preserve permanently the physical resources upon which any economy must stand?

The duty of the resource manager is to make this synthesis of scientific knowledge and to weld it into a pattern of action designed to secure the maximum of permanent economic and social values. To accomplish this end, his training must be essentially different from that of the specialist. He must be sufficiently familiar with each branch of science to evaluate its findings in terms of social significance. But his training must be broad enough that he will understand the necessity for the use of all sciences rather than any one in solving the problems which he will face. There is a clear need for a special and as yet undeveloped type of educational process by which men can secure both the general knowledge of the physical, biological, and social sciences and the ability to fuse them into that single, general activity called resource management.

In most educational institutions, undergraduate programs in these sciences are oriented in the direction of training specialists or technicians, skilled in a relatively narrow field. Graduate programs carry this specialization still further. All too often only very limited emphasis is put upon the integration of the work in these sciences or even of the various disciplines within any one of them. In most cases integration is left to chance. Narrow departmentalized specialization has become the keynote of education in most schools. The complexities of modern life demand something more than specialized knowledge in a single field. The Pacific Northwest, the country as a whole, need men with a broader training, with broader concepts, so that every phase of resource management will become progressively more effective. Procedures should be designed to synthesize all the elements—social, physical, and biological — involved. Such studies would give particular attention to the inter-relationships of the resources themselves and of the various public and private agencies involved, and to the social and economic problems that arise in the course of resource utilization.

To provide the type of training necessary, a special kind of graduate program is essential. In keeping with its interest in the scientific management of regional resources, the Council has devoted much time and thought to the type of graduate program that would best provide the broadly trained personnel desirable. The problem has been discussed at length with a number of the leading administrators not only in the Pacific Northwest but in other parts of the country. The graduate programs of all the leading universities have been carefully scrutinized. With this background a tentative program outlining the organization and curriculum of a graduate school of resource management has been prepared as a basis for further discussion.

The Control of Venereal Disease Near Military Areas in the State of Washington

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In the spring of 1940, when plans were being made for national defense and for expansion of our military forces, the necessity for an increased effort with reference to the control of the venereal diseases was apparent to everyone acquainted with the subject. In the past, the dislocation of men's lives occasioned by the sudden and tremendous increase in the size of our military forces has always led to a tremendous increase in the incidence of the venereal diseases, both in these men and the civilian population in areas near military concentrations.

In the last World War more than seven and one-half million days were lost from duty by our army, navy and marine forces, because of morbidity due to the venereal diseases. This was equivalent to the absence from duty of twenty-one thousand men for a year's time. No statistics of comparable accuracy are available on the civilian population at that time, but it is reasonable to assume that there was a correspondingly high morbidity amongst civilian groups associated with these military forces. The problem confronting army and public health authorities in this emergency was one of developing procedures which would prevent the recurrence of this increase in venereal disease incidence—an increase which would nullify all the gains in venereal disease control which have been made during the past few years.

There are two distinct phases to venereal disease control programs in military personnel—one of these involving the points which are directly under the control of the military authorities; the other involving the points which are distinctly beyond their control. The army has complete control over its venereal disease cases and can handle them in any manner which is found satisfactory; it can also make use of certain measures designed to prevent infection among its personnel, including intensive information programs, and the establishment of prophylaxis stations in appropriate localities. The fact remains, however, that the army does not produce its own venereal disease cases but instead acquires them from civilians in surrounding communities. The venereal disease rate in the army, therefore, is partly dependent upon the measures which the military authorities adopt to prevent infection among their personnel, but is to a larger extent dependent upon the venereal disease rate, and the opportunities for venereal disease transmission in surrounding civilian communities. It was realized at the outset, therefore, that the most effective possible program would be one which included the cooperative efforts of military and civilian agencies.

The broad outline of such a cooperative program was developed and agreed to by the army, navy ,and the United States Public Health Service, and provision was made for the development of local programs under the terms of this agreement. The chief points in this agreement provided for the establishment of adequate prophylactic and informational programs by the military forces; for adequate treatment facilities by civilian agencies; and for free exchange of information regarding cases and contacts between civilian agencies and military forces. The agreement also recognized the fact that the venereal diseases are enabled to exist among us because of sexual promiscuity, and recommended the suppression of commercial aspects associated with such promiscuity, or in other words, the suppression of commercialized prostitution. This is a perfectly logical recommendation because it has been shown many times that commercialized prostitutes

are the most promiscuous class existing in our present day society. The soundness of the recommendation has been proven by subsequent events.

In the state of Washington the program was developed along three chief lines: First, clinical facilities and personnel were increased in areas which were—or likely to become—important in relation to national defense, in order that diagnosis and treatment of civilians oculd be adequately handled. Second, epidemiological staffs connected with venereal disease clinics were increased to insure early diagnosis and control of infectiousness through treatment. In addition, a male epidemiological worker was added to the staff of the State Department of Health to work among the army personnel, and secure direct information regarding civilian contacts from army venereal disease cases. Third, an informational program was started to acquaint the public with the dangers of commercialized prostitution in connection with the transmission of venereal disease and to secure public support for a program of suppression of commercialized prostitution. There has been no change in this three-point program since its inception other than that emphasis has been changed on the points from time to time, and of course, all phases of the program have not developed with equal rapidity.

The increase in treatment facilities and personnel was accomplished without any great difficulty, the staffs and equipment of existing clinics being augmented at once. In addition to this, two new clinics have been established in the Western Washington defense area since the program began. Epidemiological staffs were also increased quite rapidly and have functioned very efficiently in contact investigation and case-finding. Some idea of the extent and effectiveness of the epidemiological program can be gained from a summary of the results of the program as related to army personnel.

From July 24, 1940, when the cooperative program with the army went into effect, until December 1, 1941, the army posts in Western Washington reported 1,032 cases of venereal disease to the State Department of Health. During interviews these 1,032 cases named 1,135 recent contacts who might have been the source of their infection, or to whom they might have given the infection. In most instances the contacts could be looked upon as the source of infection as they were the only contacts reported by the men within the incubation period of the disease in question. The vast majority of the cases were gonorrhea, the proportion being about twenty cases of gonorrhea to one of syphilis. Approximately half of the reported cases were imported from outside the state and gave contacts in the areas from which they had come, while the other half originated within the state and gave contacts in communities near the military posts in which they were stationed. Requests for investigation and examination of the contacts were sent out to local health departments on all cases where the information was sufficiently definite to make investigation worthwhile. The information was considered to be too poor to be of any use in 107 of the 1,135 contacts. In other words, investigation was attempted on 1,028 contacts.

No information regarding the result of the investigation has yet been received on 389, or 37.8 per cent of the contacts. A large percentage of this group were contacts in other states, which may have been examined but on which the report to us has been neglected. Reports have been received on the remaining 639 contacts, comprising 62.2 per cent of the group. 259, or 40.5 per cent, were reported to have been examined and found infected. 150, or 23.5 per cent, were reported to have been examined without any evidence of infection having been found. 230, or 36 per cent, were reported as not being found and consequently not examined. This work, then resulted in the removal of 259 sources of venereal disease from circulation and eliminated them as possible hazards to army

personnel, as well as to civilians. This must have inevitably prevented a considerable number of infections which otherwise would have occurred in the army, but there is no way in which the precise effect of this work on army venereal disease rates can be evaluated. After several months of this program, however, it became apparent that these procedures alone would not control venereal disease in the army satisfactorily—for in spite of these efforts and the very excellent prophylactic program carried on by the army, there was a slight, but constant, trend upward in the army venereal disease rate. A further examination of our records on contacts named by army personnel disclosed that over 50 per cent of these contacts were prostitutes in recognized houses of prostitution, and that over 70 per cent of these prostitute contacts which were examined were found infected. It became obvious, therefore, that it was imperative to take some special action with regard to commercialized prostitution and it seemed equally obvious that the only logical procedure in this regard was the suppression of this business to as complete an extent as was possible. Other methods of eliminating the hazards of commercialized prostitution have been tried in the past but have never, under ordinary condiitons, produced any evidence of effectiveness.

A prostitution control program which included periodic examination of prostitutes and other features, was started in one area fairly soon after the beginning of military expansion and was carried on for six months without any apparent effect whatever on the army venereal disease rate. Every effort was made, therefore, to secure the suppression of commercialized prostitution in centers of population near military concentrations, and finally during the first week of August, 1941, the first real progress was made along this line when the houses of prostitution were closed in Tacoma. As might be expected, the results of this closure were not felt in the venereal disease rate until September, as cases were reported throughout August which had had their exposure in July.

In September, however, there was a noticeable effect as evidenced by a reduction of nearly 50 per cent in cases reported by the army as having contracted their infection in Tacoma, in spite of a considerable increase in strength in the units concerned. This was the first time that such a decrease had occurred that could not be explained on the basis of a decrease in strength on the post. The actual cases reported by the army as acquiring their infection in Tacoma since July are as follows:

July	29
August	29
September	16
October	18
November	18

A similar decrease has also been noticed in the total cases from all sources reported by the Fort Lewis command. In other words, that portion of the venereal diseases in the army which had been coming from the houses of prostitution in Tacoma has been shut off. To date there has been no indication of an increase from other sources, and for the first time since military expansion started there has been a consistent downward trend in the venereal disease rate in the Fort Lewis area. A further decrease in rate on military posts in Western Washington has been produced by the complete or partial closure of houses in a number of other communities. This closure took place during the month of September in Seattle, Everett, Olympia, Centralia, Chehalis, Vancouver and Aberdeen, and several smaller places. Closure has not been complete in all of these places but has been complete enough to seriously interfere with the business and to greatly reduce the number of contacts.

The tremendous decrease in effective contacts resulting from this closure is shown by the army prophylactic records during the two periods. In the seven months prior to the closure in

Tacoma the prophylactic stations under the Fort Lewis Command had administered more than two thousand treatments per month on the average, while these stations since closure have barely averaged two hundred prophylaxes per month. A further illustration of the decrease in venereal disease among troops is furnished by one post in the vicinity of Tacoma at which nearly three thousand troops were stationed. This post had reported cases of venereal disease each month from July 1, 1940, to October 1, 1941. A venereal disease ward was maintained in the station hospital which had never failed to contain several patients during this period. Treatment of the last known venereal disease case on the post was completed in the latter part of October and the ward was closed. It had not been reopened on December 1st, as no new cases had occurred during November. These results show quite conclusively that the single procedure of closing houses of prostitution can bring about a considerable decrease in venereal disease incidence among military personnel in the area concerned. There is every reason to believe that a similar effect will be felt among the civilian population in the area. As a matter of fact, there has been a noticeable decrease in case reports of venereal disease among civilians in the areas concerned, since closure of the houses took place. Admittedly, venereal disease case reports in civilians are not a reliable index of the venereal disease incidence in this group, but if this decrease continues for a long enough period of time significance can be attached to it.

From the fact that the commercialized houses of prostitution are the most obvious and perhaps the most important single factor in the transmission of the venereal diseases, it must not be assumed that they are the only factor of importance. As I have already stated, the venereal diseases are diseases of promiscuity. They are enabled to exist because people are promiscuous in their sexual relations, and if all promiscuity were suddenly stopped by decree, or otherwise, the venereal diseases, with the exception of syphilis, would cease to exist as communicable diseases from that day on, and syphilis would be only a few weeks or months later than the others in taking its departure. These diseases must have the opportunity to transfer themselves to fresh soil in order to maintain their existence, and sexual promiscuity is the only means they have of doing this. It is true that syphilis, and occasionally gonorrhea, are transmitted through other means than sexual intercourse, but the opportunities for such transmission are far too few to maintain the existence of these organisms.

Commercialized houses of prostitution are the most important single factor in the transmission of venereal diseases simply because the inmates of these houses are enabled to make more contacts than any other types of promiscuous individuals in different circumstances. Because they can make more contacts they can transmit the disease to greater numbers of people. Other types of prostitutes, such as bar-flies and streetwalkers, are just as great a hazard to their customers as are the prostitutes in houses—the only difference between the two groups being that the bar-flies and streetwalkers have fewer customers. The program of suppression, then, should extend to all types of prostitution, and prostitution in all forms should be discouraged to the fullest extent possible.

Prostitution can never be completely eliminated, at least under our present socio-economic system. Some forms of it can be eliminated entirely, and other forms can be reduced much below the present level, if earnest and sincere efforts are made to do so, and such action will inevitably hasten the day when gonorrhea and syphilis will be historical terms.

The program of military expansion which at first appeared to be a potential hazard to the venereal disease control program has instead proven to be a tremendous asset. Under the emer-

gency of National Defense it has been possible to accomplish things in slightly over a year that would have taken generations to accomplish in the course of natural events. The chief danger is that these things will come to be regarded as procedures connected with the national emergency and, consequently, not necessary in ordinary times. There is need for the public to be made to realize that the venereal diseases are fully as destructive to peace time efforts as they are to war time efforts, and that effective control procedures are the same in normal times as in times of national emergency.

The urgent need at the moment is to make certain that there will be no interference nor interruption in the program now under way. The various phases of the program must be expanded and strengthened at every opportunity. If this is done the nation will for the first time in history emerge from a war with a lower venereal disease prevalence than that with which they entered it.

The Incidence of Syphilis Among the Selective Service Men of Whitman County

IRA G. COLLINS, A. M.
Bacteriologist, Whitman County Health Department

Since the Selective Service Act of 1940 was enacted there have been a large number of men from all over the United States who have been examined. A blood specimen was taken on each man and a serological test was performed for syphilis. A rate of 4.5 cases of syphilis per hundred men examined was found through physical examinations and routine serological blood tests of the first million men examined throughout the United States. It is interesting to note how Whitman County compares with the other counties of Washington and also to that of the first million men examined.

The incidence of syphilis among the selective service men of Whitman County compares quite favorably with the incidence of syphilis among the selective service men of other counties throughout the State of Washington. There are eight laboratories in the State of Washington that are doing a serological test on all the selectees inducted into the army. Of the eight laboratories in the state, five are county health laboratories, two are city laboratories and the other is the State Health Department laboratory at Seattle.

In Whitman County there have been a total of seven hundred and fifty-four tests made on selective service men. Of these there have been six positives and one doubtful. This makes the percentage slightly less than one percent. As the State College of Washington, located at Pullman, is in Whitman County, quite a large percentage of these tests were made on college students; and it is quite striking to find only one positive among four hundred and sixty-six students tested. This leaves five positives and one doubtful among the other two hundred and eighty-eight men tested throughout the county. This makes the percentage among college students twenty-one hundredths of one percent, and among the other men two and eight hundredths of one percent.

In comparing Whitman County with the other four counties in Washington where there are county health laboratories, there were in Yakima County a total of 1,222 tests made with six positives and two doubtfuls, or a percentage of seventy-one hundredths. In Clark County a total of nine hundred sixty-six tests made with eleven positives and six doubtfuls, or a percentage of one and seventy-five hun-

dredths. In Chelan County a total of five hundred thirty-five tests were made with three positives and one doubtful, or a percentage of seventy-four hundredths. In Clallam County a total of two hundred forty-six tests were made with eight positives and three doubtfuls ,or a percentage of four and forty-seven hundredths. Whitman County had a total of seven hundred fifty-four tests made with six positives and one doubtful, or a percentage of ninety-two hundredths. These results show Yakima County has the lowest percentage, and Clallam County the highest, with Whitman County ranking third.

Throughout the State of Washington a total of 25,686 tests have been made with two hundred forty-one positives and one hundred sixty-one doubtfuls, or a percentage of one and fifty-six hundredths. As there are only five county laboratories in the state, the counties that do not have laboratory facilities have sent their specimens to the State Health Department laboratory in Seattle. These specimens have not been separated as to their respective counties and this makes the comparison by counties rather limited, however, the State Health Department laboratory has tested a total of 14,963 specimens with one hundred twenty-two positives and one hundred fifteen doubtfuls or a percentage of one and fifty-eight hundredths. This is for thirty-two counties of Washington, leaving King County and Spokane County, which have had their tests made principally at the city laboratories of Seattle and Spokane. Of these city laboratories, Seattle has made a total of 6,018 tests with seventy positives and thirty-two doubtfuls or a percentage of one and five tenths. Spokane has made a total of 1,082 tests with fifteen positives and one doubtful or a percentage of one and forty-seven hundredths.

These results show that Whitman County ranks among the lowest in the state and considerably below that of the first million men throughout the United States.

The Public Health Nurse in a Community-Wide Venereal Disease Control Program

MISS M. A. BRAKEL, R. N.
Venereal Disease Public Health Nurse, City Health Department, Spokane

In peace or war the health of the peoples of a nation is paramount. However, in war, with its family dislocation the protection against and control of Venereal Diseases becomes more intense and urgent today. The leaders in the Public Health movement place the Public Health Nurse as a primary agent in health protection and health promotion. These workers are aware that acceleration of defense activities multiplies their obligations and responsibilities if adequate protection is to be maintained in concentrated civilian defense and Military areas.

The causative agents of these diseases, their way of attacking man and their scope are now well known, thus the V. D. Program in a community is centered in the need for:—

(1) Continued education of the public through the individual and various organized groups within the community.
(2) To provide sufficient treatment sources.
(3) Holding the patients to treatment.
(4) Locating the source and placing all infected contacts under treatment.

The liberalization on the view-point of the public toward genito infectious diseases has unleased a large barrier in a community-wide program which is a part of a unified national program. Specialized and general Public Health Nurses are now available in most defense areas in the State. Legislation covering pre-natal Wassermans and Selective Service Medical Examinations has opened a still larger field. For the rich as well as poor marry and have babies, and the Selective Service Act is not limited to any economic stratum of society. In fact, any one who desires a free blood test may have it at the Spokane Clinic, with guidance for treatment if needed.

The Spokane Clinic treats patients of all age groups both City and County residents for Syphilis and Gonorrhea, emphasis being made on those patients in the age group of 20-28 years. Private physicians of this community are making excellent use of the free arsenicals and Sulfonamides furnished through the Social Security Act.

During the year 1940, 440 Gonorrhea patients and 1,935 Syphisis patients were treated by the Spokane Clinic. The private physicians in the City reported 85 Gonorrhea and 103 Syphilis patients under their care for the same year.

The discovery of the disease creates both personal and environmental problems for the patient. Intelligent and sympathetic understanding of these problems by the Public Health Nurse is the first step in holding the patient to treatment and in discovering the contacts.

Immediately following diagnosis is the best time for the first interview by the Public Health Nurse. There is no standardized formula, therefore, the Public Health Nurse must know how to meet an emotionally up-set patient, one who is belligerant and uncooperative; one who has fear of the disease: or fear of ocnsequences; as well as the informed patient who is anxious to cooperate.

The first interview should involve the development of a long time relationship, be well prepared, and speedly executed before the patients interest wanes:

(1) Place the patient at east and give encouragement for successful continuous treatment.
(2) The interpretation of the disease, how it is contracted, and how it is transmitted.

(3) Place the responsibility of contacts on the patient, persuading them to bring in their own contacts when possible.
(4) Instruction in hygenic care at home and in the community.
(5) Attempt to forestall lapse of treatment.
(6) Aid in solving personal problems either by Clinic personel or other cooperating agencies.

Even a more tactful approach is essential for the contacts who may not have the disease, or be unaware of their exposure. Care is taken to protect the contact and patient by resourcefuulness and intution. Contacts living outside local jurisdiction are reported to the State Health Department and contacted in the area they reside.

For case holding, frequent interviews in cheerful surroundings and privacy of the Clinic are necessary to have a satisfied patient for a long period of treatment. The treatment given in the Spokane Clinic complies with that given in V. D. Clinics through-out the nation and uniform measures of reporting treatment and contacts are utilized to facilitate continuous services for patients moving to new localities. Regularity of treatment reflects the success of the first interview.

A few words about case finding which includes the following channels:

Pre-natal Clinics, Private Physicians, Selective Service Men, Junevile Court, Foodhandlers, Beauty Operators and other licenses, other Clinics, contacts of known cases, voluntary examinations, Jail, Contacts reported by Fort George Wright and known prostitutes or street walkers. The latter group and their cohorts are registered in the City Identification Bureau, facilitating easier follow-up on merely descriptive contacts.

In conclusion: I have attempted briefly to show that in the eradication of Syphilis and Gonorrhea sweeping measures are uncovering unknown cases of infection.

That in Defense areas and mobilization of troops, the problem of control of genito infectious disease is intensified. That emphasis is made on contacts and treatment of the age group from 20-28 years of age.

That infected individuals need to know what the disease means to them, their family and friends, what treatment is required and how to get it.

The knowledge and skill in understanding human behavior with the art of help is a challenge and responsibility for the Public Health Nurse.

Finding cases and holding these cases until adequately treated and rendered non-infectious is the mainspring of the Venereal Disease Program.

In enumerating the major health problems of this country, Dr. Thomas Parran said in his paper "Public Health Nursing Marches On," presented to our Silver Jubilee in October, 1937, "The Public Health nurse must bear the brunt of the battle." Spokane is doing its part to meet this challenge in the Prevention and Control Program of Venereal Diseases.

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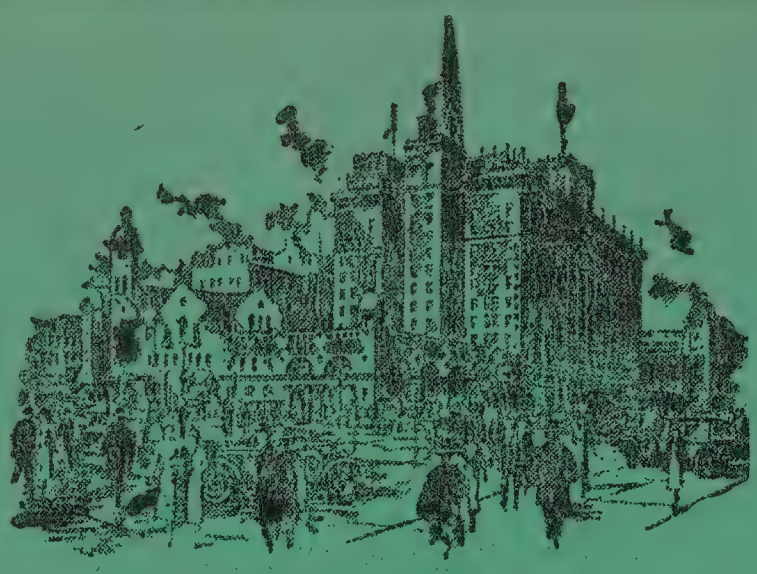

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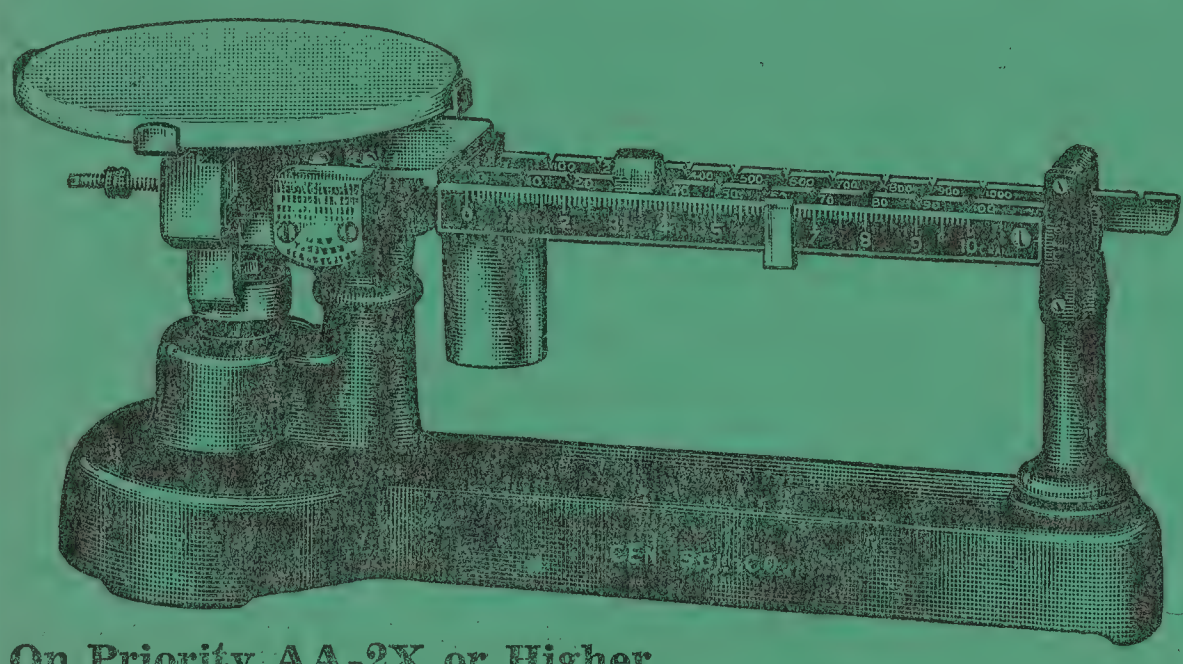

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-:- NORTHWEST SCIENCE -:-

Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes I to XVI, 1927 to 1942, each $1.25
All Sixteen Volumes, $16.00

Editor, Otis W. Freeman, Cheney, Washington

VOL. XVII, NO. 2. **MAY, 1943**

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IN MEMORIAM—T. C. ELLIOTT

The death of T. C. Elliott, historian and former member of the Northwest Scientific Association, occurred at Walla Walla on May 3. Mr. Elliott was 81 years old. He was an authority on early Northwest history and had published many papers in this field. Mr. Elliott was the recipient of an honorary degree from Amherst College and the Oregon State College. He will be missed by his many friends in the Pacific Northwest.

BIOLOGICAL RESEARCH IN THE COLLEGES

JOHN E. FLYNN

Editor-in-Chief, Biological Abstracts, Philadelphia, Pennsylvania

I.

A previous communication* has called attention to the large and apparently increasing amount of sound biological research that is being done in the liberal arts colleges, teachers colleges and junior colleges throughout the United States and Canada. In the United States alone, biologists in over 200 of these colleges are producing research contributions of merit; from another 200 or more, reports have been received of research in progress, though no recent publications have been observed.

Much of this research is very fine indeed, particularly in the fields of protozoa, porifera, bryozoa, and the photoperiodic responses of animals. Excellent work has also come from these institutions in parasitology and helminthology, ecology—both plant and animal—genetics, cytology, systematic botany, entomology, histology, herpetology, ornithology, and mammalogy. There can be no doubt whatever that there is, in this country, an actual increase in the research activity of the colleges.

There is, however, much need for further development in this direction. There are at the present time about 1,000 colleges in the United States in which there seems to be no indication whatever that research in biology is being attempted.

II.

The hindrances to research activity and biological scholarship and instruction in the colleges are of several types. Chief among these is the exceptionally

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heavy teaching load so often required of college teachers. Teaching loads in excess of twenty hours per week are by no means uncommon. Often the college teacher is obliged to deal with so wide a variety of subjects that research, if possible at all, can be done only under the tremendous handicap of excessive fatigue.

Teachers are frequently isolated, and thus deprived of the stimulus that derives from association with one's colleagues. Library facilities in the sciences are often primitive and inadequate, or for practical purposes nonexistent. The teachers of biology are often competently trained, and are not infrequently individuals who hold doctorates from strong American universities; quite frequently they are ambitious to carry on research, but are so poorly provided with laboratory appliances and library facilities that they are—or believe they are—unable to do so.

Lack of official encouragement of research, or more often, actual official disapproval, is another serious handicap.

It is pretty obvious that in many of these institutions, the biologists on the faculty are either dormant or discouraged; they are out of touch with the current development of the biological sciences, and not in effective communication with their biological colleagues. Library budgets are small, and few if any of the scientific journals are purchased. Teaching is often based on the textbook and laboratory manual, or on the textbook alone.

III.

My own interest in research in the colleges has been mainly prompted by the observation that, over a period of years, the research activities of many of the great universities have tended toward curtailment. Some recent studies have shown an actual decrease in the research productivity of the universities. From many sources we have had disturbing information, unfortunately too well confirmed, of reductions of budgets, and of teaching and research staffs in the great universities, and of inability to finance and continue research projects. Research in institutions of all kinds, especially including the large endowed universities and research institutions, undoubtedly faces lean years. We face the prospect of high taxation, reduced income from securities, lowered standards of living, and diversion to other purposes of resources that normally would have been devoted to research and higher education. If, in our own country, the sciences are to escape a prolonged eclipse, we will have to exert ourselves to the utmost to facilitate research wherever it can be carried on, and to preserve the research spirit.

IV.

For these and for many other reasons that will readily occur to the reader, encouragement of this trend toward research in the colleges is one of the most important of the issues before American biologists. If the premise is correct that research and higher education in the post-war years face exceedingly grave financial difficulties due to the tremendous national debt, and the economic policies, or necessities, that preclude the accumulation of the huge fortunes which have so largely sustained research and higher education in the past, then we must cherish every serious attempt to develop, throughout the nation, research programs that are locally founded and close to the people. Moreover, now that we have on our hands a war which amounts to a crisis in human progress, the nation needs a full utilization of its research and teaching facilities as it never did before. Our problems will not end with the signing of a peace treaty: far from it; I believe very firmly that a full utilization of the scientific talent in all the colleges and universities of the nation is one of the most important problems before us at the present time.

While it is true that the first responsibility of the administration and the faculty of a college is to provide for

its teaching program, there are serious objections to the theory that teaching and research are antithetic activities. Dr. Albert C. Casey, in an article in Science a few months ago, adduced a good deal of evidence that in the great medical schools research activity and competence of instruction are closely associated; the more research published from these, in the major research journals, the larger the proportion of their graduates passed state board examinations. In the colleges also, many instances could be cited in which outstanding teaching goes hand in hand with excellent research. It seems too that the institutions that encourage research by their faculties are better able to retain outstanding men. I think we can also suggest a reason for this. A large proportion of the men who go into biology, or chemistry, or physics, do so with the ambition of adding something to the stock of man's knowledge. Too often these men are later swamped with teaching and administrative duties and thus deprived of the satisfaction that comes from a research career. If, however, the institution is wise enough, or strong enough, to enable its scientific staff to make some progress toward realizing their research ambitions, then teaching in a small school becomes far more satisfactory than otherwise it would be.

Far too often the theory prevails that research and good teaching are incompatible activities; that the college, in selecting its faculty, must choose between having good teachers and having investigators, and cannot hope to find individuals who are good teachers and at the same time capable of adding to the stock of man's knowledge through research activity.

True enough, there have been stimulating teachers, who have never manifested much interest or ability in research; and there have been eminent research men who were failures as teachers; but men who possess both abilities have been so numerous as to discredit, totally, the easy assumption that the two kinds of talent are incompatible.

The fact is, that instruction in the natural sciences becomes all the more vital and interesting if the teacher has interests that lead him beyond the facts that are, often very inadequately, presented in the textbook. In too many colleges, instruction in biology barely rises above the level of rote learning. Such instruction does the student a profound disservice if it encourages the illusion that he has mastered the science, when in fact he has merely read the book.

V.

The biologists of the nation, through their national scientific societies and state academies of science, have it within their power greatly to encourage and extend research activity in the colleges. The hindrances to such research are to a large extent remediable. A closer collaboration between the colleges and the large universities would do much to overcome the isolation which so often hampers the college teacher's research. Most of the large universities would welcome such integration. Broad problems such as those of Drosophila genetics could be pursued very profitably indeed by workers in the colleges that are situated conveniently to such centers as Columbia and the California Institute of Technology where breeding stocks and large and active research staffs are available for consultation. The possibilities of cooperation in research between the college faculties and medical staffs of hospitals, in physiological, pathological and bacteriological problems, deserves serious study. Many of the colleges are situated in reasonable proximity to industries that have pressing research problems before them. A survey of the possibilities of cooperation between college faculties and such neighboring industries might be highly productive. Federal organizations of national scope such as the Wildlife Service, and the Forest Service and the Soil Conservation Service are dealing with national

problems concerning which research will be in prosecution for possibly decades to come. Many of the colleges are situated in proximity to field stations of one or another of these federal agencies. The possibility of cooperation between their staffs and the biological faculties of the colleges might well be considered.

Lack of adequate library facilities, reported as one of the major hindrances of research, especially in the more isolated of the colleges, may be alleviated to some extent by inter-library loans. With modern facilities for the procurement of relatively inexpensive bibliographic services and the use of microfilm there is no good reason why any small college should not, from these and reprint collections, build up locally a working library fully adequate for a large amount of research activity. By concentrating library holdings in the fields that the college faculty elect for their research, and by consistent use of abstracting agencies and the acquisition of reprints it should be possible, under present-day conditions, for any really serious student to acquire all the research literature that he is likely to have to consult.

There is considerable evidence that research men on the college faculties are often at a disadvantage in procuring funds that are necessary to carry out even a limited research program. The state academies of science have in many states done a great deal to alleviate this situation. Several of the foundations are already active in supporting college research. The whole problem of the financing of such research deserves very serious study by some national scientific body; and the establishment of a national service agency which would advise and assist scholars in the presentation of their requests for grants would, I believe, be of great value.

A still more serious handicap in the conduct of college research lies in the overcrowded teaching schedules that prevail in so many of the colleges. The accrediting agencies have already done much to alleviate this situation and will undoubtedly do more. The lack of support for research by college authorities, especially in the liberal arts colleges that are wedded to the "Great Tradition" of classical scholarship, is gradually being overcome as the college authorities become convinced that the best interests of the college lie in the direction of the encouragement of research and sound teaching in the natural sciences. Biologists have been, by and large, altogether too modest in presenting the claims of their science as an educational and cultural component of a well-rounded education. Far more could be done for the encouragement both of teaching and research in biology if some of the national scientific societies would direct their attention to the handicaps that affect their colleagues in the institutions that have not, so far, established a tradition of research. Biologists need to become more articulate. They need to assert the value of biology, and especially the value of biological research, upon every suitable occasion.

It is my conviction that the post-war years will see a tremendous stimulation of progress in all of the sciences and particularly in biology; and that the arts colleges, the junior colleges and teachers colleges will have their full share in this progress. The pursuit of science can no longer be interpreted as a function of the great endowed universities and the great research institutions. The development of an increased popular appreciation of research is well on the way. The amateur movement appears to be gathering strength. The goal of a broad national participation in scientific progress with competent, original work being done at every level from the great university to the small institution is becoming an attainable ideal.

THE HISTORY OF GEOLOGY IN OREGON AS REVEALED BY A STATISTICAL ANALYSIS OF THE LITERATURE

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In a state as youthful in its development as Oregon and one which has such an abundance of mineral resources, it is a matter of considerable concern to know whether the geological investigations carried on in the state are academic geological studies or are practical studies which will aid in developing the state's natural resources. Does geological research precede or follow increases in mineral production?

In an attempt to arrive at answers to this and other questions, this study has undertaken to analyze the literature written about the geology of Oregon. Specifically, the purposes of the study are fourfold:

1. To represent graphically the total literature written about the different aspects of Oregon geology.
2. To single out and compare the development and changes in the various geological fields.
3. To trace the influence of contemporary events and individuals on the history of Oregon's geological literature.
4. To relate trends in geological investigation with trends in mineral production.

Method

A definitive Bibliography of the Geology and Mineral Resources of Oregon, compiled under the auspices of, the Oregon State Planning Board, was used as the basis for this study.[1] Every item listed in the bibliography pertaining to Oregon geology was placed in one of the following seven categories: raphy, structure, petrology, economic general geology, physiography, stratigeology (metals and non-metals), and paleontology.

The total number of pages in each item was noted on check sheets under the year in which the item was published and under the appropriate category. Each item was counted only once. These items included whole books, periodical articles, federal and state documents, and dissertations. The detailed tabulation of this information will be found in Appendix A. Various combinations and interpretations of this data will be presented.

No attempt was made to evaluate these publications or to weight their scientific value or importance. The fact that much writing is published at a particular period, however indifferent much of it may be i,s a sure indication of contemporary interest and activities. The literature about geology may be regarded as is the strata of the earth's crust, i.e., as precipitated layers of evidence in the historical development of geology. These strata have been analyzed statistically in order to reconstruct the history of Oregon's geological literature.

Literature in General

The earliest geological literature about Oregon was produced in the still youthful years of the science of geology. The first articles were published in the 1850's, during a period when James Hall was actively working and publishing on the paleontology of New York state, and during the period when eastern and mid-western states were attempting to organize state geological surveys for the purpose of investigating their natural resources. Probably due to James Hall's publications dealing with the fossils of New York state and other areas an interest in fossils was extensively developed and early exploring parties made collections on

[1] Ray C. Treasher and Edwin H. Hodge, Bibliography of the Geology and Mineral Resources of Oregon, with Digests and Index to July 1, 1936. With assistance of W.P.A. Project 498-(3)-A, issued by the Oregon State Planning Board. Portland, Oregon, Conger Printing Co., September, 1936. 224 pp.

their trips to the west coast.

It is not strange then, and probably to be expected, that the earliest papers written on Oregon geology were descriptions of fossils collected from central Oregon. However, it would be strange indeed if some of the earliest papers had not been concerned with the newly discovered gold fields. Up to 1855, six articles had appeared, four describing fossils, one about gold, and one on physiography.

The following ten-year period was nearly barren, but was followed by an almost continuous and ever increasing volume of pages devoted to geology, paleontology and mineral resources of Oregon. From a total of 22 pages at the end of 1855, Oregon's geological literature reached a peak production in 1914 with 1080 pages, and a total production for the period 1850 to 1935 of 14,559 pages. (See Appendix A.)

TABLE I

Oregon Geological Literature by Five-Year Totals, 1850-1935 *

(Number of Pages)

Year	General Geology	Physiography	Stratigraphy	Structure	Petrology	Economic Geology		Paleontology	Total Pages
						Metals	Metals Non-		
1851-55	....	1	...	...	....	14	...	7	22
1856-60	....	....	...	...	....	....	1	2	3
1861-65	....	....	...	...	....	1	...	5	6
1866-70	17	....	...	...	....	72	1	55	145
1871-75	20	3	...	6	....	4	4	48	85
1876-80	7	....	10	...	....	1	...	110	128
1881-85	28	....	...	29	3	78	...	134	272
1886-90	23	11	...	...	6	16	11	122	189
1891-95	13	3	49	7	9	23	6	104	214
1896-00	128	161	57	1	2	76	70	166	661
1901-05	447	93	55	1	350	154	19	311	1,430
1906-10	679	1	72	16	2	164	84	393	1,411
1911-15	431	96	86	...	135	633	390	223	1,994
1916-20	98	67	41	47	....	704	99	348	1,404
1921-25	216	65	173	8	123	283	180	375	1,423
1926-30	407	175	164	349	314	212	59	420	2,100
1931-35	699	455	118	12	461	720	46	561	3,072
Total	3213	1131	825	476	1405	3155	970	3384	14,559
%	22	7.8	5.7	3.2	9.7	21.7	6.7	23.2	

* Source: Totals computed from figures in Appendix A.

In order to see trends more clearly, the data were totaled by five-year periods. These totals are presented in Table I and are shown graphically in Fig. 1.

The curve in Fig. 1 shows a fairly consistent growth of the literature over a period of eighty-five years. The sharp rise of the curve from 1895 to 1905 reflects the increased interest in general geology, physiography, petrology and paleontology. The plateau of 1905 to 1925 indicates a steady production of geological literature with a greatly increased economic geological literature which takes care of decreases in other fields and provides the 1915 peak. From 1925 to 1935 the rapid growth seems to be a reflection of an increase in all geological fields.

The peak of 1914 and a minor peak in 1916 of 677 pages (Appendix A) is no doubt due in part to the work of the Oregon State Bureau of Mines and Geology which was organized in June, 1913. These peaks were caused by large increases in the literature of general geology, petrology and economic geology. The increases correlate closely with the purposes for which the Bureau was created, namely, to study "the mineral resources of Oregon, with special reference to their economic products. . . ."[2] This Bureau went out

[2] "The law which created the Oregon Bureau of Mines and Geology," The Mineral Resources of Oregon, v. 1, no. 1, p. 58, January, 1914.

of existence in 1923.

What influence the present Oregon State Department of Geology and Mineral Industries has had upon the literature is not indicated in this study since the Department was not organized until July, 1937, and this study only goes through 1935.

Literature Trends in Various Fields

The trend of geological literature as discussed above shows a continuous growth, rather slow up to 1895 but rapid thereafter. Having examined the trends of total growth, it is of interest to determine the trends and growth in the individual subject fields during the eighty-five-year period.

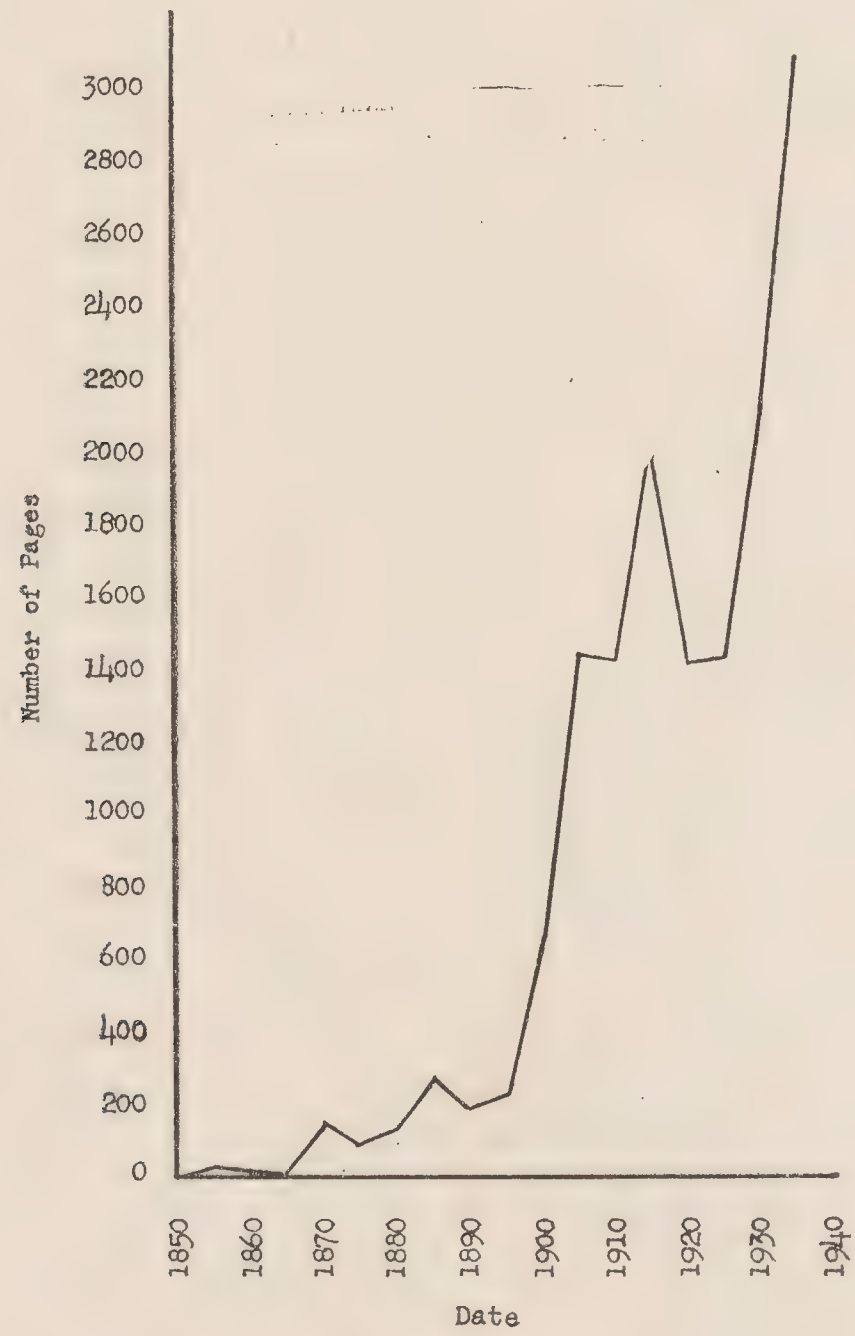


Fig. 1—The trend of the combined geological literature (all subjects) for Oregon for the period 1850-1935. (Source, Table 1.)

The data have been organized to analyze the subject trends in three different ways: (1) Percentage of total literature devoted to each subject field (Table I); (2) Relative emphasis of subject categories by ten-year periods (Table III and Fig. 2); and (3) Trend of each subject by five-year totals (Table I). The emphasis in the discussion of the subject fields which follows is organized, however, by subject rather than strictly according to these three types of analysis.

An analysis of the literature by number of pages seemed a more accurate measure than by number of articles, yet it seemed wise to check the validity of this assumption; therefore, the literature was analyzed in the same subject fields by number of articles. The percentages of the total number of articles as well as the total number of pages devoted to each subject are shown in Table II.

It will be observed that paleontology (1st), physiography (5th), and structure (8th) have the same rank in Table II. The rank of the other five subjects while not the same yet are very close. This close agreement between the two analyses is further brought out by a comparison of the percentage figures. The percentages by the two methods

are very close for every subject except non-metallics. If the metallics and non-metallics were combined, economic geology would be in top rank by either analysis since nearly one-third of the total articles or of the total pages are devoted to this subject.

TABLE II
Comparison of Subject Analyses

Subject	Rank		Percentage of Total	
	By Pages	By Articles	By Pages	By Articles
Paleontology	1	1	23.2	26.9
Economic eology (Metals)	2	3	22	18.5
Petrology and Petrography	3	2	21.7	21.2
Physiography	4	7	9.7	6.2
Economic Geology (Non-Metals)	5	5.5	7.8	6.3
Stratigraphy	6	4	6.7	11.
Structure	7	5.5	5.7	6.3
General Geology	8	8	3.2	3.6

There is such close agreement between the analysis of the literature by page and by article, it seems valid to base the rest of this paper wholly on the page analysis.

In order to further clarify the changes in emphasis in the various subject fields, the number of pages of literature were totaled by ten-year periods (Table III) and the percentages computed for each subject in each period. These percentages represent the relative importance of each subject during each ten-year period. This same information is shown graphically in Fig. 2. Physiography, stratigraphy,

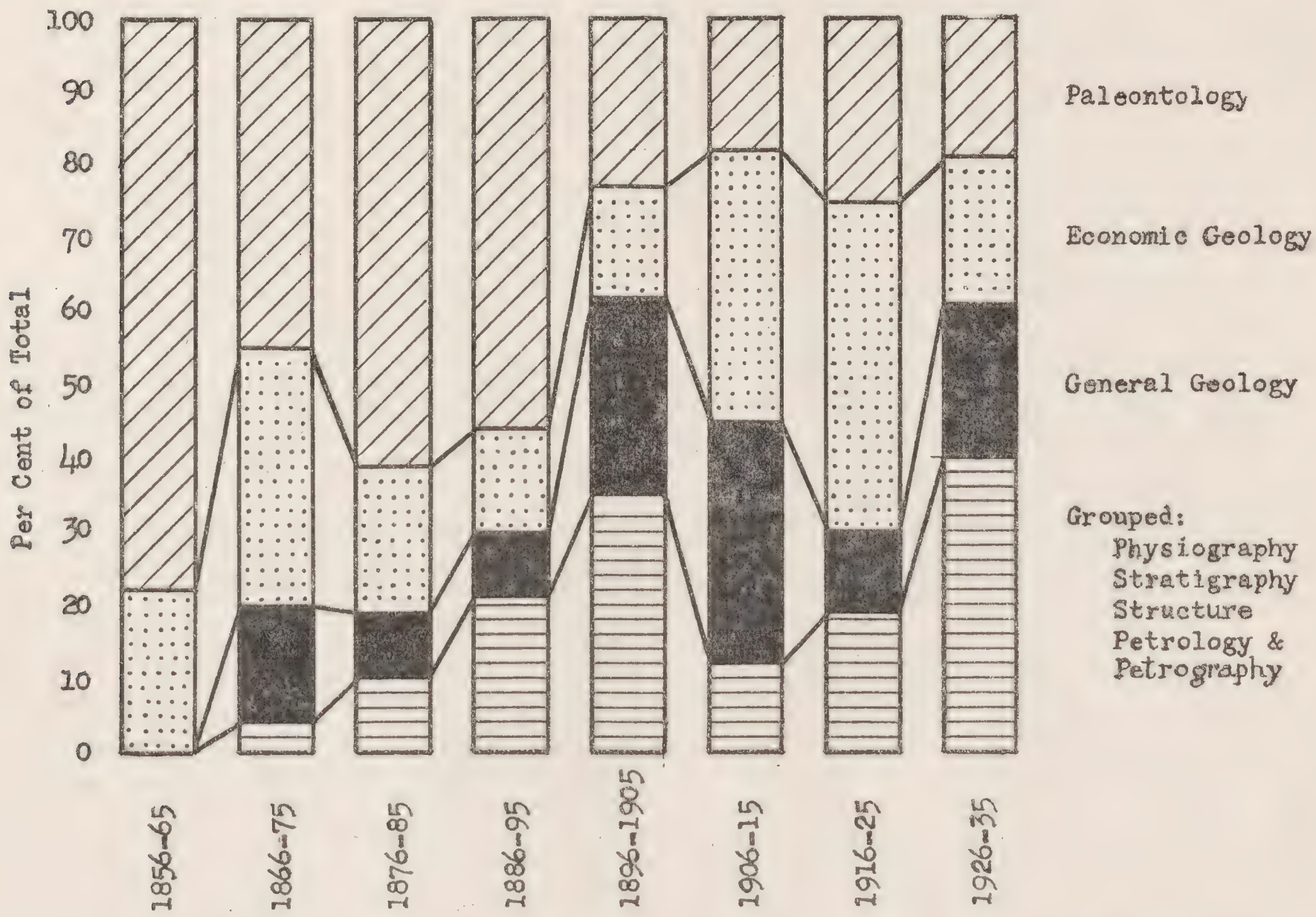


Fig. 2—Percentage distribution of Oregon geological literature by pages in four fields by ten year periods, from 1856-1935. (Source, Table III.)

structure and petrology have been grouped together since their literature growth has generally been erratic; and the metallic literature and non-metallic literature have been combined in order to bring out the strength of economic geology.

Paleontological literature (Fig. 2) is shown to be constantly decreasing in percentage value with respect to the other geological fields; the decrease being from 78% in 1856-1865 to 19% in 1926-1935. However, a nearly constant growth has taken place in number of written pages (7 in 1856-65 to 981 in 1926-1935) as shown in Table III and in Fig. 3.

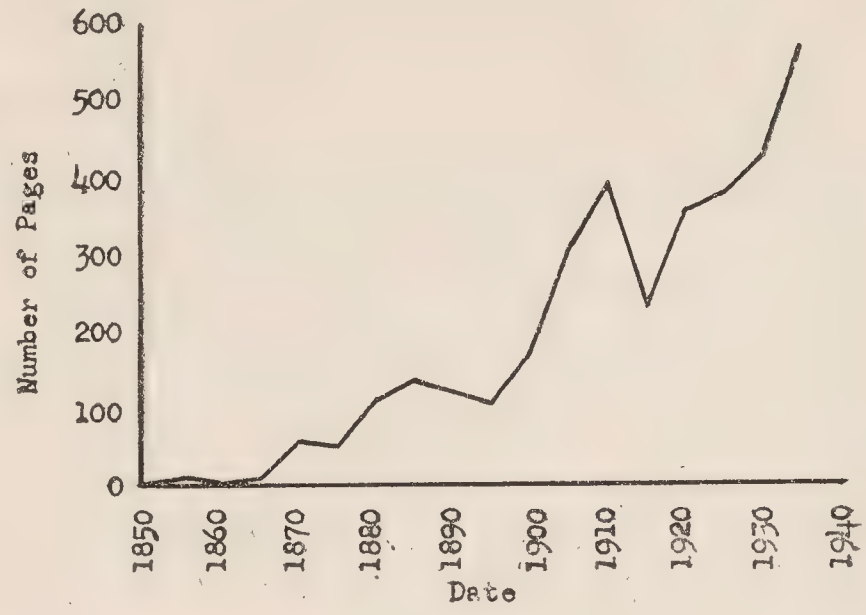


Fig. 3—Trend of paleontological literature during the period 1850-1935. Source, Table I.)

Oregon Geological Literature by Ten-Year Totals, 1855-1935 *

TABLE III

Years	4 Subjects †		Gen. Geol.		Econ. Geol.				Total
	Pages	Per Cent	Pages	Per Cent	Pages	Per Cent	Pages	Per Cent	
1856-65	....	..	....	..	2	22	7	78	9
1866-75	9	4	37	16	81	35	103	45	230
1876-85	42	10	35	9	79	20	244	61	400
1886-95	85	21	36	9	56	14	226	56	403
1896-05	720	35	575	27	319	15	477	23	2,081
1906-15	408	12	1110	33	1271	37	616	18	3,405
1916-25	524	19	314	11	1266	45	723	25	2,827
1926-35	2048	40	1106	21	1037	20	981	19	5,172
Total	3836		3213		4111		3377		14,537

* Source: Totals computed from figures in Appendix A.
† Physiography, stratigraphy, structure and petrology.

The fossiliferous John Day formation of central Oregon, the Mesozoic formations farther east, and the Tertiary flora from the volcanics of the Columbia River plateau and the Cascades have furnished much of the subject matter for the paleontological literature. The John Day beds easily rank first as source material. Their fossiliferous character was noted by early explorers and since the 1860's they have yielded a continuous supply of fossils to collectors.

Stratigraphy has had a small but consistent expression in the geological literature since 1890. It has consisted of correlations between Oregon formations and formations in other areas on the basis of fauna and flora similarities. Prominent workers in paleontology and stratigraphy have been J. P. Buwalda, R. W. Chaney, F. H. Knowlton, J. C. Merriam, E. L. Packard, and C. E. Weaver.

Petrology and petrography received little attention in Oregon until J. S. Diller began geological mapping in southwestern Oregon prior to 1902, and F. C. Calkins described the petrography of the John Day Basin. The recent upswing in the literature from 1920 to 1935 is due to studies by G. E. Goodspeed and R. E. Fuller, University of Washington, of the rocks of northeastern and southeastern Oregon respectively and by W. D. Wilkinson, Oregon

State College, who studied the volcanics of the Cascade area along the Deschutes River.

Structure has had only one notable and brief rise in 1925-1930 with sixteen articles consisting of 349 pages. The difficulties encountered in structural studies in the volcanic rocks which cover a large area of Oregon may have much to do with the seemingly low interest exhibited by the small amount of structural literature produced.

Physiography received its first impetus in Oregon when J. S. Diller brought out his hypothesis of a Klamath peneplain developed on the Klamath Mountains. The next active period from 1920 to 1935 can be correlated to the Columbia River scabland discussions, and to geographical studies of Oregon by Warren D. Smith of the Univeristy of Oregon.

Geological Literature and the Production of Mineral Resources

The public frequently asks such questions as "How is geological work and study justified?" or "How do geological investigations affect the development and production of natural resources?" One of the main objectives of this study was to try to answer these two questions by determining possible relations, if any, between geological investigations and the trends of produc-tion of natural resources for Oregon.

The trend of the total geological literature as shown in Fig. 1 should not be related directly to the production curve of natural resources as much of the literature does not have any direct bearing on mineral resources. However, since general geological studies usually precede detailed study of mineralized areas, the trends of general geological and economic geological literature will be compared with the mineral production curve (Fig. 4).

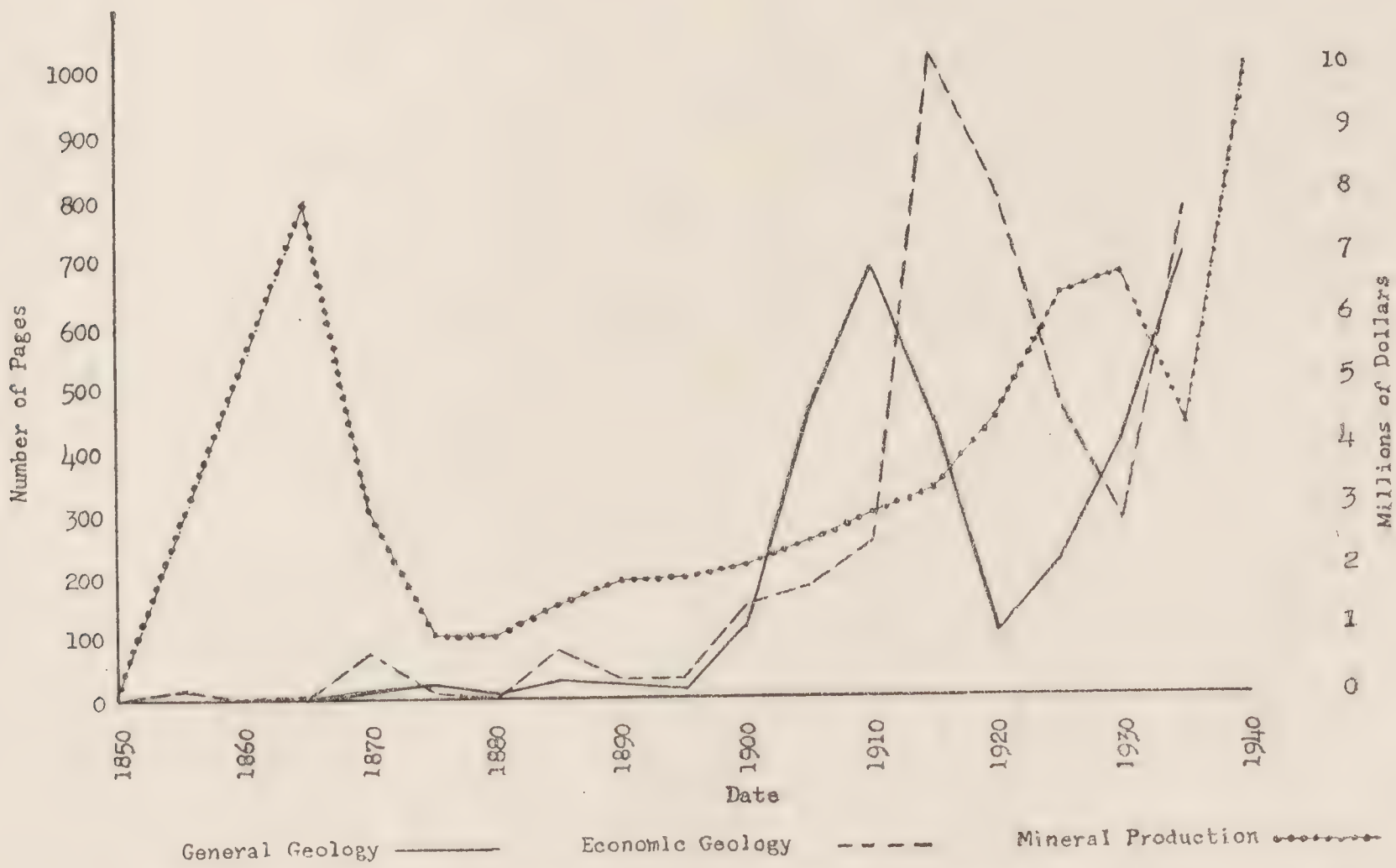


Fig. 4—Trends in Oregon Geological Literature compared with Oregon's Mineral Production for the Period 1850 to 1935. ((Source, Tables I and IV.)

Generally many structural studies are of importance in the study of mineralized areas but since the structural studies of 1926-30 were of unmineralized areas, they were not included in the comparison of the literature with the mineral production. In the classification of articles (Appendix A) if an article had an economic bearing it was placed under economic geology.

TABLE IV
Oregon Mineral Production by Five-Year Averages*

Year	Metallics	Non-Metallics	Total
1905	$1,592,156	$ 849,817	$2,441,973
1906-10	1,050,400	1,864,985	2,915,385
1911-15	1,388,993	1 871,795	3 260,788
1916-20	2,049,520	2,395,219	4,444,739
1921-25	730,390	5,656 610	6,387.000
1926-30	367,197	6,332,036	6,699,233
1931-35	874,350	3,395,129	4 269.479
1940 †	6.000,000	6 000,000	12,000,000

*Source: U. S. Bureau of Mines, Minerals Yearbook. Washington, D. C.

†Estimated by Oregon State Department of Geology and Mineral Industries (Ore-Bin, Vol. 2, no. 9, p. 63, September, 1940).

Fig. 4 shows the trends of both general geology and economic geology as becoming of general importance about 1900. The general geology trend continued to rise steadily until 1910 when a reversal occurred to reach a low in 1920 which was followed by a steady rise to 1935. From all indications the rise is still continuing. The economic geology trend follows the trend of general geology but began to lag behind in 1905 and continued a five to ten-year lag until 1930 when the curves are again nearly parallel. As shown by Fig. 4, the trends of general geology and of economic geology tend to substantiate the earlier statement that economic investigations follow those of general geology.

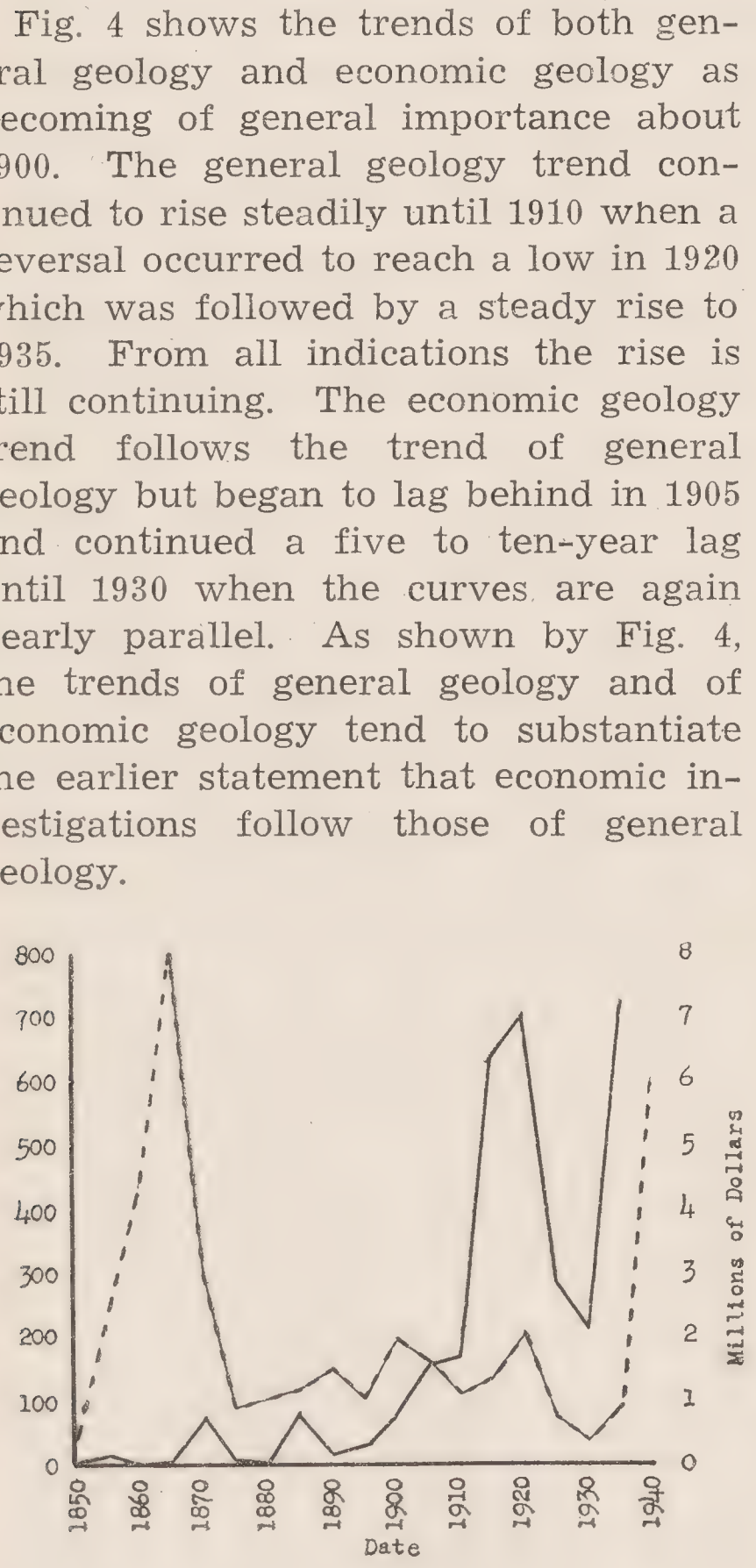
The production value of minerals, in millions of dollars, is shown in Fig. 4. After the 1865 peak production, which undoubtedly represents the cream of the placer gold ground, mineral production increased slowly but steadily up to 1915 when a sharp rise in production carried the value to a 1930 high of $6,700,000. The depression period (1931-1937) resulted in a decreased production from which the mineral industries are now emerging to reach a high for 1940 of ten to twelve million dollars as estimated by the Oregon State Department of Geology and Mineral Industries.[3]

Inspection of the three curves of Fig. 4 reveals that the trend of economic geological literature generally parallels but lags behind the general geology and is in turn followed and paralleled by the mineral production curve. The lag of mineral production may be explained as due to necessary periods for exploration, developing and financing of prospective producing areas.

The curves of Fig. 4 seem to answer the questions of "How does geological investigation justify itself?" and "What effect do these investigations have on mineral production?" in that periods of geological investigation are followed by periods of greater mineral production and thus are justifiable in that they lead to the development of natural resources.

In order to secure further information on the correlation of literature trends with mineral production, the economic geological literature was divided into two categories—metallics and non-metallics (Table I). The mineral production value was divided into the same two divisions (Table IV) and these were then graphed (Figs. 5

[3] Ore-Bin, vol. 2, no. 9, p. 1, September, 1940.



Metallic Production ----------
Literature of Metallic Deposits----------

Fig. 5—A comparison of the trends of metallic production (millions of dollars) with the pages of metallics literature. (Source, Tables I and IV.)

and 6). These graphs reveal that generally an increase in the literature precedes a rise in production for both metallics and non-metallics.

The relative values of the metallic and non-metallics are given in Table IV for the period 1905-1935. The non-metallics in the period 1921-1935 had a value seven times as great as the metallics. The same period shows the metallics to have received four times as much literature (Table I) devoted to it as to the non-metallics.

Two possible conclusions can be drawn from these relations, namely (1) that the non-metallics field has and is being neglected by geological investigators; or (2) that the geology of the non-metallic deposits is relatively simple and does not require detailed investigation as do the complex metallic deposits.

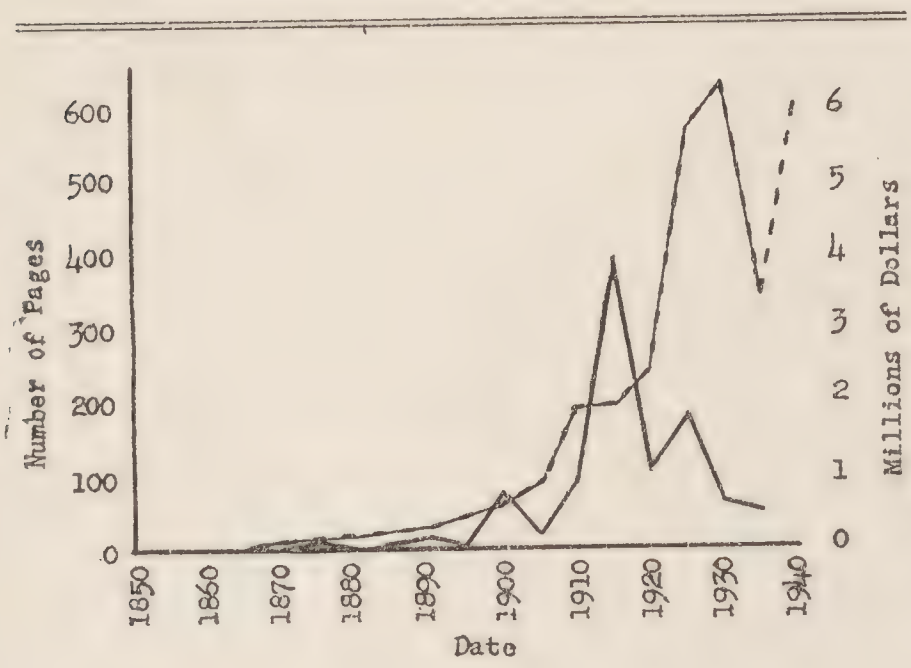


Fig. 6—Comparison of trends in non-metallic production (millions of dollars) with non-metallics literature. (Source, Tables I and IV.)

Conclusion

Some of the conclusions that may be drawn from this statistical study of the geological literature of Oregon are as follows:

1. Geological investigations have continuously expanded since 1890 as shown by the greatly increased quantity of the literature.

2. In the various geological fields, structural geology is the only field that has not shown a gradual and steady development.

3. Academic studies in geology have furnished over one-half of the literature as represented by paleontological, stratigraphic and other non-economic investigations.

4. Economic and general geological studies relative to mineral resources account for about one-half of the geological literature. The production trends of the literature parallel and precede from five to fifteen years that of the mineral production, and indicate that ever more emphasis must be placed on geological investigation of natural resources as the richer and more accessible deposits are depleted.

5. The Oregon State Bureau of Mines and Geology, in existence from 1913 until about 1923, contributed a substantial literature on the natural resources of Oregon and contributed greatly to the increased mineral production during the 1915-1930 period.

APPENDIX A

Oregon Geological Literature (Number of Pages), 1850-1935 *

Year	Geology General	Physiography	Stratigraphy	Structure	Petrology	Economic Geology		Paleontology	Total
						Metals	Non-Metal		
1850	....	....	...	...	....	....	...	....	.....
1851	....	....	...	...	....	....	...	....	.....
1852	....	....	...	...	....	....	...	....	.....
1853	....	....	...	...	....	....	...	2	2
1854	....	....	...	...	....	....	...	4	4
1855	....	1	...	...	....	14	...	1	16
1856	....	....	...	...	....	....	1	2	3
1857	....	....	...	...	....	....	...	....	.....
1858	....	....	...	...	....	....	...	....	....
1859	....	....	...	...	....	....	...	....	.....
1860	....	....	...	...	....	....	...	....	.....
1861	....	....	...	...	....	....	...	....	.....
1862	....	....	...	...	....	1	...	....	1
1863	....	....	...	...	....	....	...	....	.....
1864	....	....	...	...	....	....	...	....	.....
1865	....	....	...	...	....	....	...	5	5
1866	....	....	...	...	....	44	...	3	47
1867	....	....	...	...	....	20	...	2	22
1868	....	....	...	...	....	....	...	....	.....
1869	5	....	...	...	....	2	...	45	52
1870	12	....	...	...	....	6	1	5	24
1871	14	3	...	...	....	....	...	2	19
1872	2	....	...	...	....	....	...	2	4
1873	....	....	...	6	....	4	4	18	32
1874	....	....	...	...	....	....	...	19	19
1875	4	....	...	...	....	....	...	7	11
1876	....	....	...	...	....	....	...	....	.....
1877	....	....	...	...	....	1	...	12	13
1878	....	....	10	...	....	....	...	37	47
1879	5	....	...	...	....	....	...	41	46
1880	2	....	...	...	....	....	...	20	22
1881	5	....	...	...	....	....	...	20	25
1882	6	....	...	...	....	5	...	...	11
1883	3	....	...	...	....	2	...	67	72
1884	2	....	...	29	3	....	...	2	36
1885	12	....	...	...	....	71	...	45	128
1886	3	8	...	...	6	2	...	6	25
1887	2	3	...	...	....	1	...	9	15
1888	18	....	...	...	....	2	1	13	34
1889	....	....	...	...	....	....	7	24	31
1890	....	....	...	...	....	11	3	70	84
1891	....	....	9	...	6	4	5	39	63
1892	7	....	13	...	3	11	...	40	74
1893	....	....	19	7	....	4	...	10	40
1894	6	....	...	...	....	4	1	15	26
1895	....	3	8	...	....	....	...	....	11
1896	95	....	25	1	....	27	8	60	216
1897	13	136	...	...	....	1	...	....	150
1898	10	10	...	...	2	....	1	49	72
1899	2	13	...	...	....	3	61	7	86
1900	8	2	32	...	....	45	...	50	137
1901	54	5	4	...	10	66	...	23	162
1902	13	84	...	...	334	7	16	156	610
1903	142	....	8	...	3	33	...	6	192
1904	97	2	2	1	3	10	3	....	118
1905	141	2	41	...	....	38	...	126	348
1906	27	....	...	1	....	22	1	85	136
1907	4	1	21	...	....	12	31	136	205
1908	75	....	...	1	....	40	1	72	189
1909	386	....	51	14	....	71	25	12	559
1910	187	....	...	...	2	19	26	88	322
1911	26	....	...	...	....	8	164	48	246
1912	....	96	36	...	....	146	31	141	450
1913	15	....	46	...	....	2	26	11	100
1914	314	....	3	...	130	473	142	18	1,080
1915	76	....	1	...	5	4	27	5	118
1916	68	5	5	28	....	433	4	134	677
1917	10	3	...	...	....	17	7	8	45
1918	20	....	13	7	....	170	39	20	269
1919	....	59	...	12	....	50	5	17	143
1920	....	....	23	...	....	34	44	169	270
1921	27	....	30	...	....	98	45	41	241
1922	5	....	30	...	....	25	20	97	177
1923	41	....	5	...	50	4	27	42	169
1924	40	10	50	3	73	45	88	41	350
1925	103	55	58	5	....	111	...	154	486
1926	109	....	13	...	40	7	...	40	209
1927	120	28	11	84	81	45	11	208	588
1928	21	18	57	60	....	18	5	38	217
1929	131	119	2	175	188	20	7	86	728
1930	26	10	81	30	5	122	36	48	358
1931	97	282	50	...	165	180	...	100	874
1932	226	59	12	2	155	48	15	65	582
1933	52	95	20	8	28	387	12	256	858
1934	78	8	2	...	13	41	18	74	234
1935	246	11	34	2	100	64	1	66	524
Total	3213	1131	825	476	1405	3155	970	3384	14.559

* Source: Ray C. Treasher and Edwin T. Hodge, Bibliography of the Geology and Mineral Resources of Oregon . . . Portland, Oregon, Oregon State Planning Board, 1936.

PALEOECOLOGY OF A PEAT DEPOSIT IN EAST CENTRAL WASHINGTON

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[1] Published with the approval of the Monographs Publication Committee, Oregon State College, as research paper No. 75, School of Science, Department of Botany. The expenses of this project were defrayed by a grant from the General Research Council of Oregon State College.

Introduction

The semi-arid climate of east central Washington during the post-Pleistocene has apparently limited the amount of hydrarch succession and the resultant deposition of organic sediments suitable for pollen analyses. The Wisconsin ice of the Pleistocene glaciation extended between 16 and 20 miles south and southwest of Spokane (Flint, 1937). This represents only a slight encroachment upont he Columbia Plateau. During glacial retreat, the great volume of meltwater flowed away from the ice front in a general southwesterly direction, in both preglacial and proglacial channels, and possibly in sheet floods

Fig. 1. Pollen Profiles. Cheney, Washington.

(Bretz, 1923). This glacio-fluvial action resulted in the formation of the peculiar land form known as the channeled scablands. The scabland tracts vary in size from preglacial valleys to strips 10 to 20 miles wide, in which the Palouse soil has been entirely removed from the basalt. A vast network of anastomosing channels has been cut in the basalt. These channels are known as coulees and may be dry or carry permanent or intermittent streams. Rock basins are of frequent occurrence and lakes are present in many of them. In former stream channels ponding of water by various types of glacio-fluvial deposits has also taken place. Quarrying and plucking of basalt at the base of rapids and falls formed plunge basins, many of which retain standing water which has supported limited hydrarch plant succession. The linear arrangement of lakes indicates the pattern of the former stream drainage.

Many of these lakes, of various genesis, support hydroseres of sedge, cattail, bulrush, and other types of swamp plants. Some of the more shallow ponds have been entirely filled by organic sedimentation. These sediments are often of a mucky character, and microscopic examination has shown them to contain little or no pollen. Some of the lakes are alkaline, and peat-forming plants have been largely absent. Still other lakes, especially those formed in rock basins, have vertical shores composed of columnar basalt, and the water is too deep to permit the rooted swamp plants to invade. It is fortunate, therefore, that a deep peat deposit was located at the northern margin of Fish Lake, about 3 miles northeast of Cheney, Washington.

Origin, Chronology, and Characteristics of the Peat Deposit

Fish Lake was apparently ponded in a plunge basin at the south base of rapids in a drainage channel of the Wisconsin glacier. This channel was previously occupied by an ice-tongue which coalesced with others upon the scabland to the south between Cheney and Spangle. As the ice retreated from the Fish Lake channel, an outwash plain was formed, sloping southward into the Fish Lake basin. It is this gradual shore profile that has enabled hydrarch plant succession to reach a stage where a stratum of peat 8.8 meters in depth accumulated. The other shores of Fish Lake are rather precipitous and unfavorable for advanced stages of hydrarch succession. The unevenness of the bottom underlying the peat is shown by the occurrence of rock ledges at different levels, encountered in boring for peat samples. The ponding of Fish Lake in a basin occupied by Wisconsin ice, and later used by meltwater draining from that glacier, dates the sediments as being post-Wisconsin. It is not possible to estimate the amount of time that elapsed between glacial retreat and the origin of the sediments. The considerable depth of the peat, accumulated under dry climatic conditions, however, suggests that a major portion of postglacial time is here represented.

Peat samples were obtained at 2-decimeter intervals with a Hiller peat borer. The peat is underlain with glacial gravel resting upon bedrock basalt. The lowest level of pollen-bearing sediments is composed of fine silt, grading upward into clay. The clay in turn is succeeded by sedimentary peat, which grades into fibrous peat at 3.2 meters, the latter being present to the surface. A considerable amount of Gastropod marl is present from 6.0 to 3.2 meters. A stratum of volcanic ash is present at 6.2 meters, and glass fragments range above and below for several levels. Layers of volcanic ash, probably synchronous in origin and of the same source, are present in all bogs that have been sampled in this area. A bog at Newman Lake, about 20 miles east of Spokane, one in northern Idaho a few miles west of Priest Lake, another in northern Idaho near Bonners Ferry, and others in northeastern

Washington all contain a single layer of ash. The stratigraphic position of the ash in each case is proportionate in its position in the peat deposit. That this ash had its origin from the same volcanic activity is very probable, and it serves as a valuable chronological correlator in the several bogs of the region. The fibrous peat is composed of Hypnum moss, sedge, cattail, water smartweed, pondweed, pond lily, and plants of the submerged hydrosere. In the preparation of the peat for microscopic examination, the potassium hydrate method was used. In order to remove the crystals of calcium carbonate from the Gastropod marl, a few drops of nitric acid were added, while to remove excess volcanic glass, a weak solution of hydroflouric acid was added. This facilitated easier and more accurate pollen identification. From 100 to 200 pollen grains were identified from each horizon. In the separation of pine pollen, the size range method was used. No attempt was made to separate the fir pollen, although in the lower levels almost 100 per cent consisted of the smallest of the fir pollen; namely, alpine fir **(Abies lasiocarpa).**

Vegetation in Adjacent Areas

Fish Lake lies within but near the edge of the timbered Arid Transition life area (Piper, 1906). This area does not generally extend south of the Spokane and Columbia Rivers, but a small peninsula of it projects southwest of the city of Spokane for a distance of about 25 miles. The most important arboreal species in this timbered peninsula is western yellow pine **(Pinus ponderosa).** This species is one of the most xerophytic conifers of Pacific Northwest forests, and ranges farther down and out upon the Columbia Plateau than any other species. Farther north, lodgepole pine may be abundant, especially on the terraces along the Spokane River. As the elevation increases to the north and east, Douglas fir **(Pseudotsuga taxifolia)** and western larch **(Larix occidentalis)** become abundant, while continued increase in altitude provides favorable conditions for western hemlock **(Tsuga heterophylla),** western red cedar **(Thuja plicata),** lowland white fir **(Abies grandis),** and western white pine **(Pinus monticola).** The highest forests are composed largely of Engelmann spruce **(Picea engelmanni)** and alpine fir. The last two groups have not been abundant within range of pollen dispersal to the site of the sediments during post-Pleistocene time. The peninsula of the timbered arid Transition, forested largely with yellow pine, is bordered to the east, south, and west with the timberless Arid Transition. This area supports the "Palouse" or bunchgrass prairie, the principal species of which are **Agropyron spicatum, Koeleria cristata, Festuca idahoensis, Poa secunda, Stipa columbiana, Balsamorhiza sagittata, Wyethia amplexicaulis,** and various species of Lupinus, Astragalus, and Lomatium. Many other species of forbs and grasses are present. About 20 miles to the west of the timbered Arid Transition, beyond the bunchgrass prairie, lies the eastern border of the principal body of the Upper Sonoran life area in Washington. One of the most conspicuous plants of this zone is sagebrush **(Artemisia tridentata).** Other characteristic shrubs are antelope brush **(Purshia tridentata),** rabbit brush **(Chrysothamnus nauseosus** and **C. viscidiflorus),** wingscale **(Atriplex canescens),** hop-sage **(Grayia spinosa),** winterfat **(Eurotia lanata),** squaw currant **(Ribes cereum),** serviceberry **(Amelanchier utahensis),** horsebrush **(Tetradymia canescens),** and grease-wood **(Sarcobatus vermiculatus).** Herbaceous plants include silver saltbush **(Atriplex argentea),** poverty-weed **(Iva axillaris),** seepweed **(Suaeda depressa),** sage **(Artemisia dracunculoides),** Russian thistle **(Salsola pestifer),** and several species of Eriogonum, Erigeron, and Penstemon. In addition there are many grasses common in the Upper Sonoran life area. There are few species of trees in this zone, but an occasional specimen of white alder

(Alnus rhombifolia), peachleaf willow **(Salix amydaloides),** and hackberry **(Celtis douglasii).** The names of the more common plants are mentioned so as to indicate the possible sources of the pollen preserved in the peat.

Daubenmire (1942) classifies the area between the peninsula of yellow pine, in which the site of the sediments lies, and the higher elevations to the east as the Festuca-Agropyron association, the area to the west as the Artemisia-Agropyron association, and that to the south has the Agropryon-Poa association. The Upper Sonoran and timberless Arid Transition in Washington are included in the grassland climax by Clements (Weaver and Clements, 1938). Halophytic communities of greasewood and its associates are present in alkaline areas, on the poorly-drained, flat coulee floors where intermittent inundation and evaporation brings the alkali of the residual basalt to the surface. The mean annual precipitation at Cheney, the nearest station to Fish Lake, is almost 17 inches. The precipitation decreases west and south toward the Upper Sonoran area, while it increases north and east as the elevation increases. The site of the sediments lies within a climatic province designated as subhumid, microthermal, with adequate precipitation at all seasons (Thornthwaite, 1931). It is located extremely near the border of this province, however, with the adjacent province to the west classified as subhumid, microthermal, with inadequate precipitation at all seasons. The direction of the prevailing wind is from the southwest, but this apparently has had little influence in increasing the amount of grass, composite, and chenopod pollen in the peat profile, in spite of the fact that the regions to the southwest are predominantly covered with species of these families of plants.

Postglacial Plant Succession

The most abundantly represented species at the bottom of the profile is lodgepole pine, with a proportion of 44 per cent of the pollen present (Fig. 1). Lodgepole is usually the predominantly recorded species in the lowest horizons of Pacific Northwest peat bogs, but often with much greater proportions. In some cases it is recorded to almost 90 per cent. Western yellow and western white pine show 15 and 13 per cent respectively in the lowest level, while the total of grasses, composites, and chenopods is also 15 per cent for this level. Other conifers represented at the bottom are mountain hemlock **(Tsuga mertensiana)** with 3 per cent, and alpine fir with 1^0 per cent. The latter probably came from higher elevations to the north and east. From its maximum of 44 per cent at the bottom, lodgepole pine decreases to its lowest proportion of the profile of 12 per cent at 6.2 meters. It then fluctuates between 12 and 35 per cent to the surface. Western yellow pine shows a general and gradual increase from its minimum at the lowest level to the surface, where it is recorded to its maximum of 76 per cent. White pine declines from its maximum of 13 per cent at the bottom to nothing at 6.4 meters, from which level it fluctuates between this and 10 per cent to the surface. Grasses, composites, and chenopods decrease from the bottom to 4 per cent at 8.2 meters, then show an increase to their maximum of 23 per cent at 7.4 meters. They then decline gradually to only 1 per cent at 4.6 meters, from which level they are recorded to low proportions upward to the surface. The greatest proportions of fir are in the lower third of the profile, although this genus is represented at most horizons to the surface, where it shows 1 per cent. Western larch, which is not represented in the lower level of the profile makes its appearance at 8.6 meters with 2 per cent. This species is sporadically and sparsely represented upward to 3 meters, where it attains a proportion of 13 per cent. At the next higher level it is recorded to its maximum of 21 per cent, and then it gradually declines to 1 per cent at 1.2 meters, from which level it remains insignificant to the top. Other

conifers represented sporadically and in small proportions throughout the profile are Douglas fir, western hemlock, mountain hemlock, and Engelmann spruce. The pollen of these species probably drifted from higher elevations to the north and east of the accumulating sediments. Non-coniferous species represented by varying amounts of pollen are alder, birch, maple, sedge, cattail, and water lily. None of these groups or species are represented by significant quantities of pollen.

Interpretations of the Pollen Profiles

The comparatively low proportions of lodgepole pine in the lower levels of the profile suggest that the environmental conditions brought about by glacial retreat were not so unfavorable to western yellow pine as in regions to the north farther within the glaciated region. In a bog at Newman Lake, 20 miles east of Spokane, pollen of yellow pine was absent in the lower two horizons, but after making its appearance gained gradually to predominance upward in the profile (Hansen, 1939a). In a montane peat deposit at Boneparte Lake, in the Okanogan highlands of north central Washington, yellow pine likewise was not represented in the lowest level, but gradually gained predominance as post-Pleistocene time progressed (Hansen, 1940). Both of these bogs lie within the yellow pine forests. In northern Idaho, lodgepole was predominant early in postglacial time, but surrendered its position to white pine and larch in the upper part of the profile (Hansen, 1939a). Even in a bog located in the Upper Sonoran life area, far removed from present day forests, lodgepole was predominant in the lower levels, suggesting that glaciation to the north and west had afforded favorable conditions for lodgepole as well as the lack of competition by other species (Hansen, 1941). The early decline of lodgepole and the converse increase of western yellow pine and grasses, composites, and chenopods suggest amelioration of the conditions left in the wake of the glacier, and possibly the warming and desiccation of the climate. The invasion of grasses, composites, and chenopods in the region about Cheney, apparently came slightly earlier than an invasion by similar groups of species in the region about Newman Lake, about 35 miles to the northwest. In the bog of this study, this invasion is represented some time before the volcanic activity that is represented by the volcanic ash stratum at 6.2 meters. As previously stated, the maximum of these groups is 23 per cent at 7.4 meters, more than a meter below the position of the ash. Significant proportions of these species are maintained, however, to 3.2 meters, where they record 13 per cent, and then decline to less significant proportions. In the Newman Lake bog, with a depth of 7.3 meters, the volcanic ash stratum appears at about 4.5 meters. The maximum of grass occurs at 5.5 meters, while the maximum of chenopods and composites together is at 4.5 meters, the ash horizon. The total of the three groups in the Newman Lake bog at 5.5 meters is 46 per cent, the maximum of the profile. Significant percentages of these three groups are maintained to 1 meter, slightly higher than in the bog of this study. Thus, there seems to be a significant chronological correlation between these indicators of warming and drying in the two profiles.

The appearance of western larch pollen in appreciable proportions in the profile is rather significant. Because larch has thick bark and is better able to resist fire than the other conifers, its influx may be interpreted as an indicator of fire. This species is extremely intolerant of shade and cannot compete with other species as long as there is no disturbance by fire. The occurrence of fire, however, which destroys other species, permits larch to expand due to lack of competition. As the other species regain lost ground, they gradually replace the more intolerant larch. The recorded influx of larch, a species which at present exists at considerable distance from the site of the sediments,

is very suggestive of a fire which provided conditions favorable for the increase and persistence of this species for a short period of time. Lodgepole suffered immediately from this fire, but it later increased at the expense of larch as the conditions caused by the fire were modified. This is reflected by a sharp increase in lodgepole immediately above the larch maximum at 2.8 meters. In the bog at Newman Lake, larch shows an early increase to significant proportions followed by a decline, and then a second influx, suggesting the occurrence of a series of fires. In a bog near Bonners Ferry, Idaho, larch likewise is recorded as having made two invasions during the post-Pleistocene, and the relative contemporaneous fluctuations of western white and lodgepole pine pollen suggest a series of fires that destroyed the forests of these species to the extent of permitting an influx and persistence of larch for an appreciable period. The importance of larch fluctuation is amplified because it produces little pollen compared with the species of pine with which it is associated.

Climatically, the pollen profiles of this study and their interpreted plant succession, suggest a gradual warming and drying of the climate from almost the beginning of the post-Pleistocene, which reached a degree persisting until after the volcanic activity responsible for the deposition of the ash in the accumulating sediments. This is borne out by other profiles in the region, as well as in other areas east of the Cascades in both Washington and Oregon. (Hansen, 1940, 1942a, 1942b). The maximum of warming and desiccation was succeeded by cooling and an increase in moisture in more recent time that has persisted to the present. This is also borne out by pollen profiles and interpreted plant succession in many parts of the Pacific Northwest.

Summary

Pollen profiles of a post-Wisconsin peat deposit at the north end of Fish Lake, about 3 miles northeast of Cheney, Washington, in a western yellow pine forest, show that lodgepole pine was not as abundant during the early postglacial as in other areas of the Pacific Northwest. Western yellow pine gained early predominance and is recorded as generally increasing all the way to the surface. In the lower third of the profile, grasses, composites, and chenopods are abundantly represented, but decline toward the surface. Western larch is recorded as having sharply expanded at a time represented in the upper half of the peat profile. This suggests a fire or series of fires that destroyed the less fire resistant species for a short time.

Climatically, the abundance of grass, composite, and chenopod pollen in the lower third of the profile denotes an early warming and drying of the climate, followed by some cooling with more moisture to a degree which has persisted to the present. This is in close agreement with the indicated climatic trends as recorded by a peat profile located about 35 miles to the northeast.

The writer expresses his appreciation to Dr. O. W. Freeman, Eastern Washington College of Education, Cheney, Washington, for his assistance in obtaining the peat samples and for his suggestions and criticisms concerning the geological aspects of the paper.

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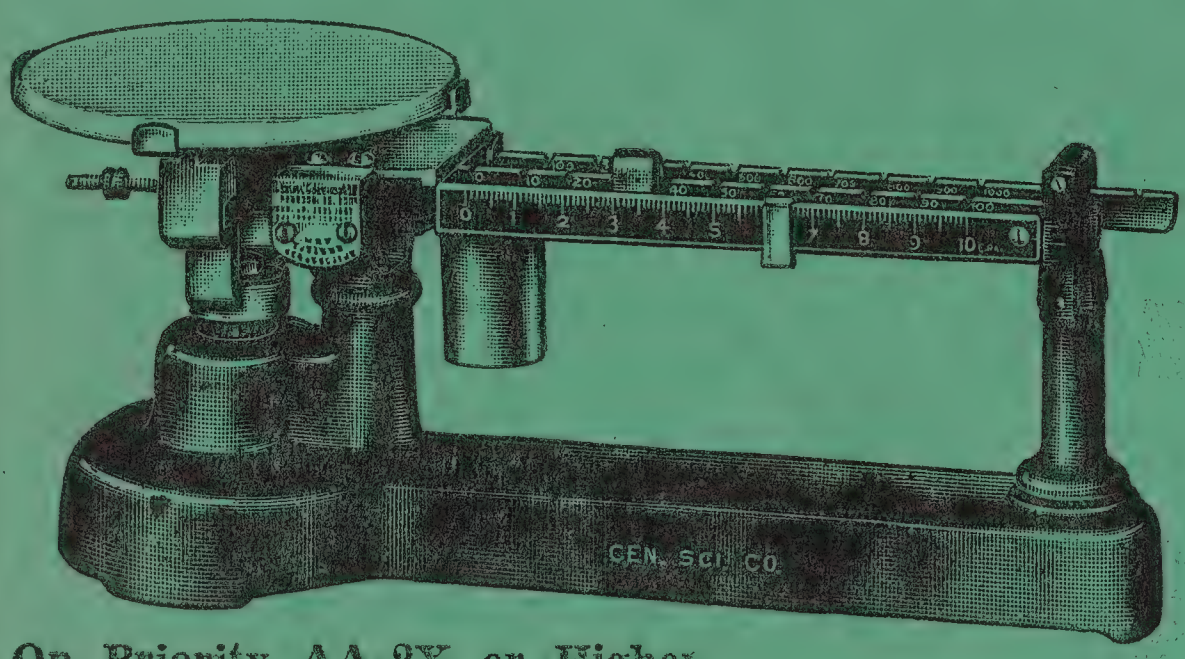

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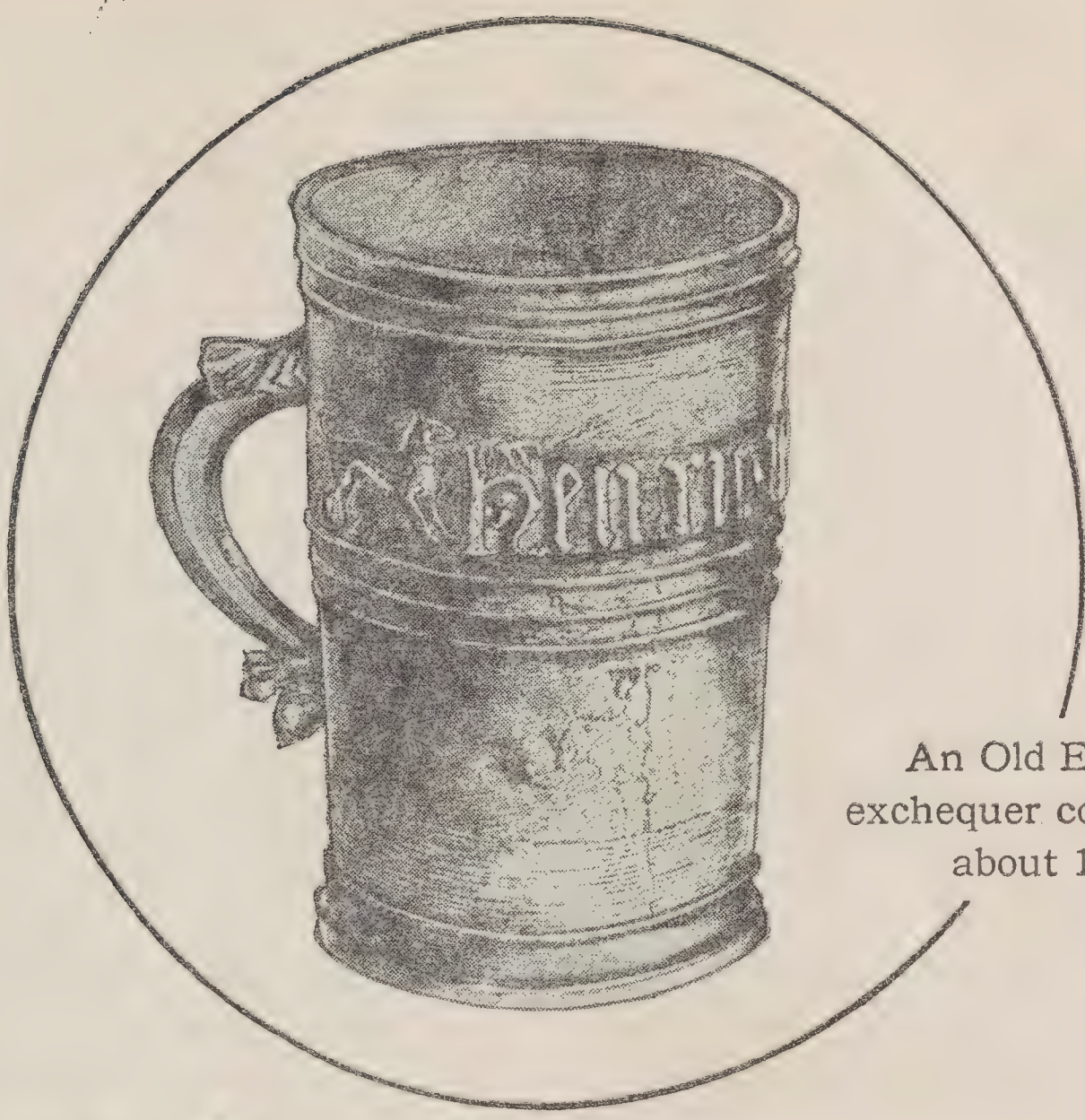

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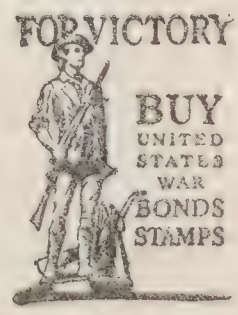

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ACKNOWLEDGMENTS

The preparation of this manuscript was in part made possible by a grant-in-aid from the Northwest Regional Council, which organization also furnished the plate of the map used for illustration. The author also wishes to thank the director of the Northwest Regional Council, Dr. John B. Appleton, for many helpful suggestions that assisted in the organization and preparation of the manuscript. Several men critically read the manuscript. Among these are: Raymond M. Miller, Industrial Engineer of the Market Development Section, Bonneville Power Administration, Portland, and J. C. Rettie and R. F. Bessey of the National Resources Planning Board. To these and others who assisted the author is deeply grateful.

-:- NORTHWEST SCIENCE -:-

Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes I to XVI, 1927 to 1942, each $1.25
All Sixteen Volumes, $16.00

Editor, Otis W. Freeman, Cheney, Washington

VOL. XVII, NO. 3. AUGUST, 1943

STRATEGIC AND ESSENTIAL MINERALS OF THE PACIFIC NORTHWEST

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INTRODUCTION

Vast quantities of supplies of all sorts are needed for a country to maintain its army, navy, airforce and other necessary activities under war conditions. In ordinary times foodstuffs, raw materials and manufactures could be secured from other parts of the earth if our country lacked certain types of such things. But during war goods are no longer free to move in their usual channels. This necessitates finding new available materials for those that cannot be secured.

Some minerals of paramount importance are found in abundance in this country. Other minerals are lacking wholly or in part. A mineral or other material that is not readily available in the quantities needed for total war efforts becomes a strategic material.

TABLE I.

Preparedness Minerals

(January, 1939)

STRATEGIC Dependence Wholly or Substantially outside Continental United States.	CRITICAL Obtained from Domestic Sources, but procurement problems are Difficult.	ESSENTIAL Essential to National Defense but Neither Strategic nor Critical.	
Aluminum	Asbestos	Abrasives	Refractories
Antimony	Cadmium	Arsenic	(Clay)
Chromium	Fluorspar	Chlorine	(Magnesite)
Manganese (Ferro Grade)	Graphite	Copper	(Olivine)
Mica	Iodine	Helium	(Diatomite)
Nickel	Platinum	Iron and Steel	(Silica)
Optical Glass	Scientific Glass	Lead	Sulfuric Acid
Quartz Crystal	Strontium	Magnesium	Including Sulfur
Quicksilver	Titanium	Molybdenum	and Pyrite
Tin	Vanadium	Petroleum	Uranium
Tungsten		Phosphates	Zinc
		Potash	Zirconium

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Various lists of preparedness materials have been made by various agencies and at different times. One of January, 1939, descriptive of minerals, is given in Table I. Notice that the necessary war materials were divided into (1) strategic, that are imported wholly or for the most part, (2) critical, that are obtained from domestic sources but whose procurement problems are difficult and (3) essential, that are needed for preparedness but appeared to be produced in adequate amounts in our own country.

There have been many changes in this list since it was issued. Our consumption of many materials was much larger than anticipated. For example, usually the United States exports copper, lead, and zinc but the preparedness program consumes such large quantities of these metals that in 1942 we had to import a quantity of all of them from Latin America. (See Hessel, et al., 1942, pp. 157-180.)*

Magnesium was listed as essential in 1939 but the demand was so great for this valuable light metal that in spite of the output of magnesium increasing 30 times in 3 years still all of it is needed for aircraft and other war machines and practically none is released by the Government to ordinary users. Strict priority control by the Government also proved necessary for iron and steel, although the amount of these produced by our country in 1942 was the greatest on record. If any table of preparedness minerals had been issued in 1942 many minerals listed as essential in 1939 would be included in the critical column. On the other hand, substitutes have been found for some strategic materials like coconut shell for gas mask carbon so that this substance is no longer considered of strategic importance.

The change of the United States from a peacetime to a war economy has required special study of strategic, critical and essential materials. Search for new sources, the use of substitutes and restrictions in the consumption of preparedness materials have proved necessary. Production of some commodities begun under war necessity may prove permanent. For example, we had no potash production at the outbreak of World War I, but consistent search for sources brought discoveries that have freed us of foreign imports and our potash requirements are now met by home output. Without the war stopping imports, delay in prospecting and development would probably have occurred. In this war possibly some industries for which our country has previously been unimportant will become important. Magnesium is already an outstanding example of this.

Mineral resources are widely dispersed over the earth. Some regions are highly favored, others lack most of the essential mineral wealth. Occurrences of mineral deposits result from geological activities in the past and hence their location has a rational explanation. However, on the map the precise location of mineral resources seems quite haphazard and the deposits are often remote from markets. About one-fourth of all ocean freight consists of minerals. Minerals also account for nearly two-thirds of all railroad freight, by weight, in the United States. Well populated countries and industrial centers may have to depend almost wholly on remote supplies of metals. Less frequently, as in Italy, even the fuel must be imported. No country in the world has within its borders all of the minerals needed by its nationals. Even the United States of America and the U. S. S. R. (Russia) have insufficient resources of several metals, while most European countries must import a majority of their mineral needs. As a result there has developed a vast international trade in oil, iron, copper, tin, and dozens of other minerals between the countries with an abundance and those who can purchase and use them. For example, the United States almost wholly lacks tin, nickel, and iodine, and must import all or a part of its needs of aluminum ore, antimony, asbestos, chrome ore, manganese ore, mica, platinum, quicksilver, tungsten, and vanadium. Yet our country is the most nearly self-sufficient in mineral production of any nation in the world.

War interferes with normal trade and may prevent a nation from importing minerals from the usual sources of supply. Then too war demands great quantities of materials into which go vast amounts of metals and non-metals. Mineral fuels are also needed for smelting and other manufacturing

*References are given at the close of each topic.

processes, besides producing mechanical and electrical power required for operations. Nations preparing for war generally import more than their current needs of the minerals that are not available at home. This excess of imports is stored and, after war shuts off further imports, supplies of essential minerals are doled out to the strategic industries as required from the stock piles that have been collected. Thus Japan imported excessive amounts of scrap iron, cotton, copper, quicksilver, and oil before attacking the United States. Our own country built up a stock pile of rubber, tin, and other materials that helped supply our needs after war began.

General methods for alleviating a scarcity of raw materials in war time include: (1) efforts to find new sources of material, (2) build up a stock pile for emergencies, (3) encourage production in nearby available sources, (4) encourage recovery of scrap, (5) discover possible substitutes, (6) collect information about strategic materials and control their distribution, price and use.

Just as different continents and countries differ in their mineral resources, so various regions of the United States show marked differences in types of minerals. The Appalachian and Mid-Western regions have an abundance of coal, oil, cement, and iron, and considerable lead, zinc, and copper, but entirely lack many of the strategic metals. The Pacific Northwest has only small resources of iron, coking coal, and natural gas, and the only proven reserves of oil are in Montana east of the Rockies. However, certain other materials are present in abundance and in 1940 the Pacific Northwest supplied nearly one-sixth of the copper, one-third of the lead, one-fifth of the zinc, one-fourth of the mercury, and one-half of the high grade manganese production in the country besides appreciable quantities of antimony, chromium, and tungsten. After 1940 defense needs and increased prices stimulated output of metals and notable increases in production of several items have been made.

In this article a complete description of the mineral resources of the Northwest will not be made; instead the space will be devoted chiefly to a consideration of those minerals which the United States ordinarily imports to at least a considerable degree. However, several minerals that may be developed in the Northwest will be briefly discussed even if the country as a whole has adequate resources thereof.

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PART ONE...METALS

IRON AND STEEL

Iron is the primary basis of all modern industrial effort and the United States is exceptionally well off in comparison with other countries since our nation produces almost as much iron and steel as all the rest of the world combined. In spite of this large output the demands of the war emergency were so great that there was a shortage of steel in 1942, and priorities were required for the purchase of iron and steel articles. Also delivery of steel plate and other fabricated forms of steel to the shipyards and other consumers as fast as needed became increasingly difficult. As a result it has been urged by many that adequate steel capacity using local iron ore should be established in the Pacific Northwest to supply much of the region's immediate needs. Three small steel plants are already in operation. There are two at Seattle and one at Portland, Oregon. All three normally operate on scrap iron with very little or no pig iron in the charge. One steel

mill at Seattle and the mill in Portland both use electric furnaces for making their steel, while the third and largest mill, located in Seattle, makes steel with oil-fired openhearth furunaces.

The closest blast furnace making pig iron is at Provo, Utah, near a source of coking coal, and reasonably close to its ore supply. Its iron is shipped to California steel mills and western iron foundries.

Adequate markets are available in the Western States for a much larger iron and steel industry than that which now exists. During the war emergency all of the steel products that are made by Western plants find ready sale to shipyards, airplane factories, defense construction, and other necessary activities. Deliveries to consumers would be more rapid from new Western mills than by continuing to import the heavy regional requirements from Eastern producers. There would also be a great saving on freight so that consumers should save money on this steel even if the price at Western mills was somewhat higher than at an eastern point. In normal peacetime the local steel mills should find an adequate market in the mines, logging camps, sawmills, farms, canning industries, manufacturing plants, and construction activities in the region. Alaska and the Orient are also normally available markets for American steel. Miller (see references at close of section) states that in 1934-5 864,629 long tons of iron and steel products were shipped by rail and water from Eastern mills to the Pacific area (including California) plus 514,326 long tons to the territorial and foreign export markets. Consumption has much increased since the middle thirties and the substantially enlarged markets should consume more than all the steel that the Northwest can produce in existing plants.

Deposits of iron ore are widely distributed throughout the Northwest. While proven tonnage of ore is not large compared with iron resources in Minnesota and Michigan, it is believed to be adequate for a plant that might produce several hundred thousand tons of pig iron and steel annually. The common ores are all oxides of iron. They are called magnetite, which is a black magnetic iron ore, hematite, which is a red iron ore, and limonite, a brown hydrous iron ore. In Oregon limonite ore occurs in Columbia county about 25 miles northwest of Portland. While the proven ore is small the probable ore may amount to several million tons. Magnetite deposits are known in both southwestern and the extreme eastern part of Oregon. In western Washington magnetite ore is known in the Cascade Mountains near the headwaters of the Snoqualmie and Skykomish rivers, and both hematite and magnetite ores occur near Blewett Pass and north of Cle Elum as well as in central Skagit County near Marblemount. In northeastern Washington magnetite, hematite, and limonite ores are found in Okanogan, Ferry, Stevens, and Pend Oreille counties. Three small mines are in operation. One in Okanogan County and one in Stevens County supply ore for mixing with magnesite at Chewelah to give that refractory product desired color and other properties. A mine in Pend Oreille County supplies iron ore used in the manufacture of cement. In all 5,386 tons of iron ore were mined in Washington and nothing in other Northwest states in 1940. For comparison the United States mined 73,695,899 tons of ore in that year, and nearly 100,000,000 tons in 1942. Idaho and western Montana have numerous occurrences of iron ore, but insufficient development work has been done to prove the tonnages available. Among the occurrences is a body of high grade hematite located in the Little Belt Mountains of central Montana where several millions of tons of ore are reported to occur. In addition to possible domestic sources it should be possible to import ore from Alaska, British Columbia and Chile by ocean vessel to plants built in seaports on the lower Columbia River and Puget Sound.

As regards fuel, while there is little coal in Idaho and while the coal of Oregon at Coos Bay is not suitable for making coke required for fuel in blast furnaces, there is coal of coking grade in western Washington, British Columbia, and central Montana which can supply an iron industry. Coke has been made successfully from seams of coal in the foothills of the Cascades in eastern King and Pierce counties, Washington. Vancouver Island and the Crows Nest district in British Columbia also possess resources of coking coal.

Coke might be imported if needed from Utah. Another possibility for the operation of a Northwest iron industry is electric smelting. It is possible that charcoal recovered as one of the products from the distillation of wood, might be used to make special high grade steels by the electric furnace method. Charcoal is free of sulfur and other injurious elements often present in coal. With the abundant cheap hydro-electric power available in the Northwest electric smelting for iron ore may be more practicable than the ordinary blast furnace. It is also quite possible that special grades of steel alloys might be made by electric smelting of domestic ores and local supplies of the required alloy metals that are required. These alloy metals will be described later.

Iron from the smelting operation is called pig iron. It always contains considerable carbon and silicon as well as some manganese and the impurities, phosphorus and sulfur. Foundry pig iron is used for making iron castings, while basic pig iron is converted into steel. Iron with too little carbon content to be capable of hardening is called wrought iron. This form of iron is soft and ductile and is used for making water pipe, boilers and boiler tubes. wire, sheet, bar, and small structural shapes. Steel is the toughest form of iron. Its carbon content is above that of wrought iron, and is varied to give the steel the desired hardening ability. In addition to carbon, steel may contain certain alloying metals, such as manganese, silicon, chromium, vanadium, molybdenum, nickel, cobalt, and tungsten which help give it valued properties like toughness, high tensile strength, hardness, and corrosion resistance. Methods of heat treating have been worked out to give steel the properties desired for various sues.

Steel is made from pig iron and scrap steel in fuel-fired open hearth furnaces, and in electric furnaces. The latter are used for making the better grades of steel and the alloy steels. Normally about half the furnace charge is scrap although many Western plants use scrap exclusively. In 1942 an electric steel plant and rolling mill was under construction in the Northwest which included an electric furnace with an annual capacity of 35,000 tons of steel ingot. This will be the second such plant in the Northwest, and will use scrap iron and not pig iron for its raw material.

A shortage of scrap iron in the United States began to be noticeable in 1942 as a result of the greatly increased steel production for the war emergency, and an accompanying decrease in the scrapping of old machinery. It has been proposed that plants to make "sponge" iron from iron ore be erected to supply this product to make up some of the scrap iron deficiency. Such a plant could operate on ore from either Oregon or Washington.

The sponge iron process is the first used by man for making iron from its ores. The ore mixed with coke or charcoal is heated in a furnace at a temperature of about 1500 F. This degree of heat is not sufficient to melt the iron but does reduce it to a spongy or a powder form mixed with the nonmetallic ore minerals. In one process the iron is reduced to a mass of sponge and slag. By hammering the hot mass the slag can be removed and wrought iron produced. In actual practice the sponge iron may be used directly in the open hearth furnace as a substitute for scrap iron in the manufacture of ordinary carbon steel or it may be used as the raw material for making a high grade carbon steel. The advantage claimed for the sponge iron process over ordinary blast furnace practice making pig iron is that low grade ores can be used, less heat is required, and the cost of the plant is less.

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ALLOY STEEL METALS

Steel has long been the leading material for weapons of war and machines of peace. As mentioned in the preceding section, the addition of certain elements to iron forms ferro-alloys of superior hardness, toughness, resistance to wear and corrosion, and other qualities needed for tools, machine parts, and munitions of war. The United States leads the world in the output of automobiles, trucks, aircraft, machine tools and other products needed to win the war in large part because we have the alloy steels needed for such materials and the skill, management and determination to build and use them. The victory of our country in war and its leadership in machine manufacture for times of peace stems directly from our ability to make and use alloy steels.

MANGANESE

Manganese is the most necessary of all the strategic metals. It has value both as an alloy with steel and as a means of removing impurities from steel. A salt, manganese dioxide, is used in storage batteries and manganese compounds are used in glass making and in certain paints and dyes. However, such chemical uses account for a scant 5% of manganese consumption; the balance goes into steel manufacture. In steel metallurgy, the metal, which is combined with iron in a form called ferromanganese, is added to molten steel. The manganese combines with oxygen remaining in the iron, thus deoxidizing the molten metal to make strong sound steel. Usually twelve to fifteen pounds of manganese are required for each ton of steel deoxidized. The standard ferromanganese contains about 80% manganese; the balance is iron and carbon. Spiegeleisen, ferroalloy of manganese, contains about 20% manganese, the rest being iron and carbon. It also is used in steel deoxidation. Since spiegeleisen contains less manganese than standard ferromanganese, low grade ores can be used in its preparation. No substitute for manganese compounds in removing residual oxygen from steel has yet been discovered. Manganese is therefore a most important essential in steel manufacture. Unfortunately manganese once used in steel making cannot be recovered as secondary metal. It is not practical to extract the manganese from steel scrap as can be done with nickel, copper, iron, lead, and zinc scrap of various sorts.

Most of our supply of manganese is imported usually from Russia, India, and Brazil. Cuba is a producer from low grade ores in times of high prices like the present. When Germany attacked the U. S. S. R., exports from that country stopped and in 1942 it became very difficult to import manganese from India. Every effort was therefore made to increase domestic output of the metal. Montana first became a producer of manganese in World War One. Thereafter most of the mines closed except for those at Philipsburg, Montana. This district maintained a fairly steady output of high grade ore that supplied most of the chemical manganese demands of the country. That needed in metallurgy was nearly all imported. Only about eight per cent of the manganese consumption was supplied by domestic producers during the 1920's and 30's. The present largest producer of manganese in the country is the Anaconda Copper Mining Company. In the Butte district the central zone carries mainly copper but the veins in an outer zone of mineralization have value chiefly for zinc and manganese. The manganese occurs as a silicate mineral called rhodonite and the carbonate called rhodochrosite. The manganese ores are concentrated in a plant at Butte before shipment. The ore averages 20 percent manganese and is concentrated to about 40 percent by the use of "soap" as a flotation agent for the mineral and by heating in kilns to remove carbon dioxide. The Emma mine there is said to contain the largest known deposit in the world of the pink manganese ore, rhodochrosite. Manganese reserves at Butte approach a million tons of ore. In 1940 nearly half of the shipping ore and concentrates produced in the United States that contained 35 per cent or more manganese came from Montana.

A small shipment of manganese ore came from Bannock County in southeast Idaho in 1940. This deposit is near Cleveland and yielded over 5,000 tons of ore between 1924 and 1928 that ran

42 per cent manganese. In the past some production of manganese has come also from Shoshone and Lemhi counties, Idaho. While there was no recorded production in that year from either Oregon or Washington both states contain deposits of manganese and during the national emergency can develop at least a small output. Manganese deposits in Oregon are chiefly found in the Klamath mountains in the southwest and the Blue Mountains in the northeast part of the state. Most of the occurrences have been little developed and the past output has been small. In Washington, beds of manganese ore that vary from one foot to nearly 30 feet thick occur at intervals in a belt that nearly encircles the Olympic Mountains. Considerable development work has been done and some ore has been shipped in the past A mine at Lake Crescent in Clallam County was producing 50 to 60 tons of ore per day in 1942. Manganese is also reported from Skagit and Okanogan counties, Washington.

As means of supplying the manganese needed by the steel industry the United States Government in 1942 announced its intention to build three large and seven small plants to treat domestic ores many of which are of low grade. The large plants are to be built in Minnesota, South Dakota, and Nevada. Two of the small plants will be built in Montana, and in Utah and will serve producers in the Pacific Northwest. It is expected that all of these plants when in operation can produce 600,000 tons of manganese annually—a far greater output than has previously been recorded for this metal by the United States and one adequate for our needs.

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CHROMIUM

The metal chromium is one of our most needed strategic metals. About half of the total consumption is used for making stainless steel, and other ferroalloys for tools ,armaments, and machinery. In ordinary times chromium-plated parts are popular for decorative use on automobiles and metal furniture. The common ore of chromium is chromite, an oxide of iron and chromium, and the material is usually sold under the name of chrome ore or chromite. Chromite finds direct use in the steel industry as a refractory (heat resistant) material. Here it is generally used in the form of chrome brick in open hearth furnaces. It is neutral in composition and is inserted to separate the basic hearth from the acid furnace roof lining. Chrome brick is rather brittle and when used in furnaces there is a loss of consumption by wear of about one and one-half pounds of chromite per ton of steel. Less than half the total consumption of chromite goes into refractory brick for furnace lining.

The metal chromium is used as a bright plated surface coating for rust-proofing steel parts, and is also used in a large group of alloy steels ranging from the rustless and stainless group of 12 to 30 per cent chromium steels, to the low chromium alloy steels used for tools, machine parts, and so forth. The stainless steels contain 18% Cr and 8% Ni, and because of their corrosion-resistant property and high strength are used for engine valves, gears, turbines, cutlery, surgical instruments, and, in general, in places where resistance to oxidation, chemical corrosion and wear is desired. Special low-

chromium steels are used for armor plate, armor-piercing projectiles, burglar-proof safes, guns, crusher jaws, stampmills, and so forth.

Ferro grade chrome ore is smelted in electric furnaces with coke and scrap iron, producing a 70% chromium ferrochromium, which is the raw material for making the chrome steels. However, one process used for the stainless group of alloy steels utilizes ferrosilicon directly to reduce chrome ore to steel in an electric furnace without passing through the ferroalloy stage. This direct process can use the low grade chrome ores that prevail in the West.

Chromium compounds are used as mordants (dye fixing agents) in dyeing cloth, in tanning leather and as pigments for certain paints. A considerable amount is used for dyeing the olive drab cloth used by soldiers.

While magnesite or forsterite (olivine) brick may be substituted for chrome brick in steel furnaces, and substitutes may be found for some of the low chromium steels, yet there is no satisfactory substitute for stainless steel, or for chrome steel armor plate. Both of these are widely used by the army and navy. Supplies of chromium are therefore essential for national defense. Deposits of the mineral chromite usually occur in association with basic rocks (iron magnesium silicates) containing the greenish yellow mineral called olivine and the alteration product thereof called serpentine.

Chromite is brought to the United States chiefly from South Africa, the Philippine Islands, and Cuba. Other sources are New Caledonia, Greece, India, and Turkey. With the outbreak of war, receipts from many of these sources were cut off. Russia is a large producer, but this supply was also not available.

There are numerous occurrences of chromite in the Pacific Northwest. During World War I there was great need of the material and the high price of chromite then stimulated production. Deposits of chromite in Alaska were mined to some extent and it is believed could produce considerable ore under good management. Certain chromite occurrences near the southern tip of the Kenai Peninsula, Alaska, one of which has good grade of ore, are now being developed. Other Alaska deposits are at Port Chatham and Red Mountain. In Oregon chromium ore occurs in the Blue Mountains of Wheeler, Grant, and Baker counties. About 13,000 tons of chromite came annually from small mines in these counties in the last years of World War I. Mines near Canyon City in Grant County were most important. Another center is Josephine County in southwest Oregon. Here the individual deposits are mostly small and reserves are difficult to estimate. However, it is thought that considerable chromite is available for mining since many deposits are known. Over 100 chromite properties have been found in Oregon. Their past production totals nearly 40,000 tons and known reserves are close to 70,000 tons. In 1918 production was nearly 20,000 tons; two-thirds from eastern Oregon and one-third from the southwestern part of the state. Most of the Oregon chromite deposits are small but from all taken together a substantial production should be possible.

The most important chromite deposits undergoing development in the country are in Stillwater and Sweet Grass counties, Montana. Here in 1942 three mills were under construction and it was expected that a production of 600,000 tons of concentrates annually could be reached in two years. The largest mines are the Benbow and Mount in Stillwater County. Funds for development were furnished by the Federal Government and the management by the Anaconda Copper Company which, however, does not share in the profits if any. These chromite deposits are quite large and in 1940 were estimated at nearly two million tons of material of at least 15 per cent chromite content. Since the chromite bearing zone in the ultra-basic rocks is about 30 miles long the discovery of additional ore bodies may be expected. Improved construction of roads to the properties and the building of additional mills have been recommended. While it is probable that costs of producing the chromite will be high and that it might be unprofitable to extract in ordinary times, the large scale operation of the properties during the national emergency is fully justified. Now that chromite is badly needed price is a secondary consideration. The Bureau of Mines has been investigating

all possible means of economically recovering chromite from low grade ores and it is possible that some of these Montana chromite properties can continue to operate after the war in compeition with foreign producers. Elsewhere in Montana chromite occurs in Carbon and Madison counties.

Another source of chromite in Oregon is "black sand" found on both modern beaches and elevated ancient beaches. The black sand is named from the heavy dark minerals of which it largely consists. These are magnetite, chromite, ilmenite, zircon, and a little manganese oxide. The black sand occurs in lenses from a fraction of an inch to over 30 feet thick. The overburden that must be removed in mining operations varies from a few feet to seventy feet. Estimates have been made that 90,000 tons of sand containing 5% or more of chromite exist in present beaches, and that ancient raised beaches contain 1,400,000 tons of sand of 5 to 9% chromic oxide about one per cent zircon. Geologists believe additional resources will be found. Since magnetite is magnetic the location of concealed bodies of black sand can be found by magnetometer surveys. Methods have been worked out to extract the chromite and zircon and a mill to handle 2,000 tons of material a day is under construction. A substantial output can be expected by 1943. The beach sands were first worked for placer gold in 1852 and a considerable amount has been recovered from the deposits. Later the sands were a source of platinum of which small production is still made. Zircon, a zirconium silicate, is used in the manufacture of firebrick and for baked-in enamels. It will be a useful by-product of the chromite beach placers. Ilmenite (iron-titanium oxide) is in demand as a source of titania for paint pigment.

In Washington chromite has been located in Kittitas County, on Cypress Island in the San Juan group, and at a number of places in the northern Cascades, especially in Whatcom County. No significant production has resulted from work done, however.

No chromite deposits of importance are known in Idaho.

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TUNGSTEN

Tungsten has the greatest tensile strength of all metals, and its most important use is in the manufacture of steel and other alloys. Tungsten is an especially valued strategic mineral because our nation normally supplies only part of its needs for this important constituent of high speed tool steels. Usually about 90 per cent of the tungsten used in this country goes into tool steel. The special tool steels have the valuable property of retaining their hardness and power of cutting even at red heat. They therefore can operate at higher speed and do more work in a given time than is possible with tools made of ordinary carbon steel. Tool steel usually contains from 10 to 20 per cent tungsten and perhaps 5 per cent chromium and vanadium with the balance iron and carbon. Molybdenum is often substituted for some of the tungsten since the United States produces most of the world's output of molybdenum and must import most of its tungsten.

An extra hard cutting tool for special purposes is made of tungsten carbide. This is made by chemical fusion and contains some cobalt. It is expensive but is exceeded in hardness only by the diamond and may last 100 times longer between sharpenings than the usual high speed tool steel. Tungsten carbide will even cut glass and porcelain, for which ordinary tools are useless. Tungsten is used in several alloys without iron, for example, stellite. This alloy is a mixture of tungsten, chromium and cobalt. It is used for cutting tools that work on the steel

used in machine parts and for facing in places subject to abrasion and wear like the lip of a power shovel. Tungsten alloys are used in hacksaws, dies, stamps, drills, car springs, tractor treads, grinding rolls, and many other places wherever a surface is subject to extra heavy wear and tear. Tungsten is used in electric lamp filaments and radio tubes, but the wire is so fine that national consumption from this cause is only about 30 tons per year. The savings in power by use of tungsten filaments in place of carbon is very remarkable and saves many times the cost of the metal to the consumers. The metal tantalum could be substituted for tungsen in light filaments but is not nearly so satisfactory.

In armaments tungsten steel has been used for armor plate, the erosion resistant liners in heavy cannon, and in the cores of armor-piercing shells.

The United States ordinarily mines from one-third to one-half of its tungsten requirements. However, in 1940 this country produced 65 per cent of its consumption of about 8,000 tons. Usually this country imports tungsten largely from China and lesser amounts from Latin American countries like Bolivia, Argentina, Peru and Mexico. The capture of Burma by the Japanese in 1942 closed the Burma Road outlet for tungsten from China and increased the need for a larger domestic production. This need has grown especially with the vast increase in the consumption of tungsten in tools and armaments required in defense activities. In 1940 over 5,062,000 pounds of tungsten were shipped from mines in the United States and the output has increased since then. There are several ores of tungsten but in the Northwest scheelite (calcium tungstate), wolframite (iron-manganese tungstate) and hubnerite (manganese tungstate) are the most common.

California, Colorado, and Nevada have been the chief tungsten mining states. However, considerable tungsten exists in the Pacific Northwest and the output is important. Probably the leading district for tungsten production in the United Staes is the Yellow Pine or Stibnite mines in the rugged mountains of Valley County in central Idaho. At Stibnite the Bradley Mining Company operated mines that produced gold, silver, and antimony. Stibnite is the name of the common ore (antimony sulphide) of antimony. Development work disclosed rich bodies of tungsten ore. The district also possesses deposits of mercury. The Stibnite mines in 1942 were large producers of both antimony and tungsten, both highly important strategic minerals. Tungsten also occurs in other places in Idaho, but the output has been small except from Valley and Lemhi counties. The Ima mine near Patterson in Lemhi County is an important producer. Its output is used for the manufacture of filaments used in electric light globes.

In Washington the Germania mine southwest of Springdale in southern Stevens County produced 86 tons of tungsten concentrates in 1940. In 1939 the output of this mine was 221 tons of concentrates. The mine closed in 1942 but has been reopened since. Before World War I the mine was owned by German capital and received its name at that time. This management produced around 5,000 tons of ore which after concentration was shipped to Germany until the outbreak of war. Production continued during the war to help supply the needs of the United States, but after that the mine was closed for many years until purchased by the General Electric Company, who in this way secured tungsten for light filaments. Other tungsten prospects are known in Stevens and Ferry counties, near Pateros in Chelan County and other places in the state but production from them has been small.

In Montana a mine at Jardine, near Yellowstone Park, is the only producer of tungsten. The Jardine Mining Company shipped 42 tons of scheelite concentrates in 1940 and 20 tons in 1939. Chief values are in gold and the tungsten is a by-product.

In Oregon tungsten has been reported near Baker and in the Klamath mountains, but there has been no significant production.

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BERYLLIUM

Beryllium would be a very valuable constituent of certain alloys but so far it is an "infant industry," and production is still largely experimental. Beryllium metal is hard to extract from ores and sells at a nominal price of $45 per pound—which makes it impossible to use for ordinary purposes. Most of the beryllium is sold in the form of a 4% master alloy with copper. In this form the material sells for $15 per pound of contained beryllium. In actual use the content of beryllium is reduced to under one per cent, perhaps as low as 0.1 per cent. Copper-beryllium alloys have superior strength, hardness, and high electrical conductivity even at temperatures around 500° F. Tools made of this alloy seldom spark like steel tools, which is a valuable property near explosive materials. Beryllium alloys have remarkable tenacity, and resistance to corrosion and "fatigue," which makes them of the utmost value for delicate springs in gauges and other instruments. Other possible beryllium alloys are with iron, nickel, chromium, cobalt, magnesium, aluminum, carbon, and silicon. The possible beryllium alloys and their uses are being investigated, but as indicated few are being produced. Until large quantities of beryllium are available at reasonable prices the use of the metal must obviously be restricted.

Beryllium is present in a hard complex mineral called beryl. This often occurs in dikes with feldspar and mica. Some of the beryl comes as a by-product from the mining of these materials. The actual production of beryl has been 100 to 200 tons annually in the United States. Most of this was consumed in the pottery industry. Eight hundred tons of beryl were imported from Argentina and Brazil in 1940. Probably if beryllium is produced on a large commercial scale in the United States most of the beryl ore must be imported from South America. However, beryl occurs in many states includingn Idaho, where it has been found in the central and northern part of the state. A deposit near Deary, Latah County, Idaho, may become a producer of beryl. Beryl has been reported near Index in the Cascades of Washington. (Glover, p. 114.) According to a newspaper report (April 23, 1943) a deposit of beryllium has been discovered 20 miles north of Gold Hill, Oregon. Likely careful search may locate other beryl occurrences in the Pacific Northwest.

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COBALT

The metal cobalt closely resembles nickel and also has uses that somewhat resemble those of nickel. Specifically, cobalt is a constituent of certain alloys used for high speed tools. Stellite is such an alloy. Malleable stellite consists entirely of chromium and cobalt. It has been used for tableware, surgical and dental instruments, knives, and decorative objects. The hard non-malleable stellite contains tungsten or molybdenum or both, alloyed with cobalt, and is used to make high speed tool steel. Cobalt salts are used for coloring glass and pottery, and for various other purposes.

Cobalt is not produced in the United States except for a small tonnage from the refining of other metals. For instance at an electrolytic zinc plant at Kellogg, Idaho, in 1940 there was recovered 93 tons of residue that con-

tained 3.29% cobalt, but none was shipped. Most of the world's cobalt comes from Africa—Morocco, Belgian Congo, and northern Rhodesia—from Ontario in Canada, and from Bolivia. The African countries account for 75 to 80% of the total.

In the Pacific Northwest cobalt has been reported from Chelan and Ferry counties in Washington, in northeast and southwest Oregon, and central and northern Idaho. No production has ever been recorded except that mentioned above as a by-product of other operations. However, a deposit in Lemhi County, Idaho, may supply some cobalt in the future.

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MOLYBDENUM

Molybdenum is an important alloy steel metal which can often be substituted for tungsten, nickel, and chromium. Usually molybdenum is used in steel along with manganese and chromium. In this combination it produces a self-hardening steel that is said to be somewhat tougher than the corresponding tungsten steel. Tool steel containing molybdenum retains its temper and hardness at red heat like tungsten alloys. Molybdenum alloys are well suited for making crank shafts, propeller shafts, axles, safes, rifle barrels, cannon, and other things where great tensile strength is an essential.

Molybdenum is an essential metal for an armament program but is not a strategic need in the United States as this country produces over 90% of the world output. The Climax Molybdenum Company of Colorado leads the world in output and accounts for two-thirds of the United States supply. The balance is mostly recovered as a by-product of copper mining operations in Utah, Arizona, and New Mexico.

In the Pacific Northwest several tons of molybdenum have been produced in the Deertrail district near Fruitland, Stevens County, Washington. Molybdenum has been reported from other prospects in northeastern Washington and the northern Cascade Mountains. Some molybdenum ore has been mined in Chelan and Okanogan counties. Molybdenum has been found in southwest Montana, in northern and central Idaho, and in the Wallowa Mountains of Oregon, but no production of note has yet occurred in any of these sections. However, it is possible that careful exploratory work might disclose worth while ore bodies.

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NICKEL

Nickel is a strategic metal in the sense that the United States lacks the metal and must import nearly all of its requirements. In 1940 some 554 tons of nickel were recovered in this country, all as a by-product of copper refining. In addition 2,920 tons were recovered from secondary sources like scrap metal. The United States consumes well over one-half the nickel in the world. However, about 80% of the world output comes from Sudbury, Canada. With the friendly relations that exist between our country and Canada, the United States can always have access to this supply of nickel. The island of New Caledonia, an appendage of France, but occupied in 1942 by Australian and United States forces, produces most of the rest of the world's nickel. There is a small output from Greece, Norway, and Finland available to the axis powers, but the United Nations control over 95% of the world's nickel.

Nickel is used as an alloy metal in stainless steels and in other alloys with steel and non-ferrous metals. Chief uses of the nickel alloy steels include automobile, airplane, and other machine parts, like axles, gears, shafts, bearings, and connecting rods. Much of this steel is used by railways in turbines, pumps, bridges, machine tools, tractors, and parts of heavy machinery of all sorts that are subject to heavy duty and wear. Nickel is also alloyed

with copper, zinc, and other metals besides iron for special uses. Monel metal is 67% nickel, 28% copper, and the balance of iron, manganese, silicon, carbon, sulfur, and sometimes aluminum. Monel metal is used for rust-proof trim and hardware, and in fittings for hospitals, laboratories, kitchens, and laundries where a resistant, corrosion proof material is needed. Hundreds of uses have been found for it. Nickel steel is used for the armor plate on warships, bullet jackets, gun forgings, and many other purposes. It is an essential material for armaments. While little nickel goes into five-cent coins, nevertheless the formula for the manufacture of "nickels" by our government was changed during the war to conserve this valuable metal.

In the Pacific Northwest no nickel has been mined. However, occurrences of nickel have been reported from all the four Northwest states. A low grade nickel deposit of some size has been found near Riddle in southwest Oregon. Surveys have disclosed nickel in several places in northern Washington, central Idaho, and southwest Montana, but no commercial ore bodies have yet been developed. In Alaska on Chichagof Island eighty miles southwest of Juneau sulfide ore bodies containing about 10,000 tons of ore that contains 2% of nickel and %1 copper have been located. In addition several million tons of a dark basic rock called norite contain perhaps 0.2% nickel and 0.1% copper. Probably the small concentrated ore bodies could be worked in a minor way, but the big disseminated deposit is below commercial grade. Another Alaska nickel-copper deposit is located on Baranof Island.

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VANADIUM

Vanadium is classified as a "critical" mineral by the Army and Navy Munitions Board. The metal is an essential war material but the problem of supply is not so difficult as a material classified as strategic. At the rate of about 4 pounds per ton the metal goes mostly into alloy steels that are used for armor plate, tools, artillery, and railway, bus, and truck axles and crankshafts. A new vanadium-titanium-aluminum steel alloy has been developed for certain uses. Minor uses are in the glass, ceramic (clay product), and color industries. A compound of vanadium is used as a catalyst (assists in chemical reaction) in one process for making sulfuric acid. The United States output of vanadium totals about 2,000,000 pounds annually and comes mostly from Colorado, with minor amounts from Arizona and Utah. Peru is the largest foreign producer and supplies somewhat more vanadium to this country than comes from domestic sources. South Africa is also a source of vanadium and a little comes from Mexico. In the Pacific Northwest vanadium has been found in the phosphate rock of Idaho, Wyoming, and Montana. The reserves of this rock total about 6,000,000 tons and are estimated to contain millions of tons of vanadium. The Anaconda Copper Mining Company makes fertilizer from phoshpate rock of southeastern Idaho and has built a plant at Anaconda, Montana, that recovered 150,000 pounds of vanadium in 1942 from residues that previously had been thrown away. The vanadium exists in the residue as vanadyl phosphate, which, when, treated with steam, ammonia gas and ammonium nitrate, is first changed into ammonium vanadate. This on further heating is converted to an oxide of vanadium, in which form it is sold for alloying with steel. The company expects to recover from 50 to 200 tons of vanadium annually, which would be a substantial addition to the United States output of about 1,000 tons per year. Another plant is planned for western Wyoming that will operate on a deposit in shales associated with the phosphate beds. Abroad, the vana-

dium for ordnance needs in Germany is secured as a by-product from blast-furnace slags, and in Italy by treating the soot from the smokestacks and flues of ships and industrial plants. An American firm reports considerable vanadium in the flue dust from ships' boilers burning Venezuelan oil. Doubtless if need develops, considerable additions to our vanadium supplies could be secured as by-products from various sources. Recently a deposit of magnetite in Curry County, Oregon, has been found to contain about one per cent of vanadium. Preliminary estimates indicate reserves of 400,000 tons of ore, but the real value of this discovery is as yet uncertain.

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LIGHT METALS

An extraordinary demand has developed for the light metals, aluminum and magnesium. Aluminum has been in large production for over half a century but a considerable production of magnesium has been attained only since 1940. Both are considered of paramount importance for war materials and their use during the war is strictly controlled by the government, which has financed and built many new large plants for the production of both of these metals.

ALUMINUM

Aluminum is of very great importance among strategic metals. Used for aircraft, automobiles, truck bodies, and quantities of military equipment, consumption of the metal has tremendously increased during the war emergency. The Government controls the entire output for the duration, and priorities are required for its purchase. Unlike nickel, tin, mercury, and platinum that are imported in the metallic form, it is the ore of aluminum, bauxite, which is imported. The United States has considerable bauxite in Arkansas (estimated at 8,500,000 tons of high-grade and 15,000,000 tons of low-grade ore), and some occurs in Georgia and other southern states. However, if mining is expanded to a rate of 2,000,000 tons of ore per year the domestic reserves cannot last long. Usually the majority of our bauxite consumption is imported from British and Dutch Guiana. One mine in Dutch Guina has been shipping its entire output to the United States and Canada, amounting to about 600,000 tons in 1940, and this tonnage will likely be doubled for the duration. No commercial deposits of bauxite are definitely known in the Pacific Northwest, although the mineral has been reported from Beaverhead County in southwestern Montana.

Aluminum is present in clay and nearly all rocks. However, in most of its occurrences the task of extracting the aluminum is too expensive and difficult to make it commercially feasible. Only bauxite, a hydrated aluminum oxide, has been used as an ore in the United States heretofore. In extracting the metal the bauxite is first dried in a rotating kiln to remove the water, and then is chemically treated to separate the aluminum oxide from the impurities. This purified aluminum oxide is the raw material of the aluminum reduction plants. The aluminum reduction process is electrolytic calling for great amounts of electricity, that can be cheaply generated by water power. The plants producing aluminum are therefore generally located near such cheap and abundant hydroelectric power sources as are provided by the dams and falls of the St. Lawrence, Tennessee, and Columbia Rivers. in the electrolytic reduction plants the aluminum oxide is put into a molten bath of a fused mineral called cryolite and the aluminum metal is recovered by electrolysis. The only known commercial deposit of cryolite is in southern Greenland, now guarded by United States forces. However, if this supply should be cut off, cryolite (sodium-aluminum fluoride) can be manufactured from fluorspar, soda, and sulfuric acid. Some of this synthetic product is now being used.

Aluminum was first made commer-

cially in 1888 and one company practically monopolised production until the present war emergency began when the Government supplied public funds for building numerous new aluminum plants that are being operated both by the Aluminum Company of America and several other concerns. In the Pacific Northwest by the close of 1942, five aluminum plants were in operation making aluminum pig for the war program. All of these used aluminum oxide made from bauxite and shipped to the Northwest from treatment plants on the Gulf Coast or in the Mississippi Valley. Some of the aluminum will be rolled to sheet in Northwest rolling mills built for that purpose. Much of this aluminum will be used for building aircraft in western Washington and southern California. The abundant cheap power was the principal reason for the location of new aluminum plants in the Northwest. In 1940 the aluminum production of the United States was 412,560,000 pounds. This was probably as great as that of the rest of the world combined. By the end of 1943, with new plants and additions to existing operations, the output is expected to exceed a billion pounds. This is two or three times the output of the rest of the world. The Northwest will produce more than one-fourth of this record production. The plants here are modern permanent affairs and the region should continue of importance for aluminum production indefinitely.

Aluminum is used in dozens of different alloys. These may contain silicon, nickel, copper, iron, zinc, magnesium, lead, bismuth or chromium with aluminum in almost every conceivable combination. These alloys are used for castings forgings, dies, and other purposes. Aluminum and its alloys are light and strong, corrosion resistant, and good conductors of electricity. Aluminum materials are used where strength combined with lightness is desired—as in aircraft, railway cars, truck bodies, and so forth. In ordinary times aluminum is used as kitchen ware, as a deoxidiser (removes oxygen residues) in steel making, in aluminum paint, in foil for wrapping food products, and so forth, but such uses are subordinated to military needs for the duration. Aluminum salts are used in paper making, oil refining, dyeing cloth and water purification.

While not used for aluminum production at present, considerable reserves of leucite and alunite that may serve as an ore exist in the West. Leucite is a volcanic rock, found in Wyoming and central Montana, that contains from 10 to 20% aluminum. Alunite is a hydrated sulphate of potassium and aluminum. It occurs near Enumclaw, Washington, and at Marysvale, Utah. Aluminum oxide made from these materials could produce potash as a by-product by leaching off the soluble potassium sulphate from the insoluble alumina (Eichelberger, 1941). In 1942 a plant to make aluminum from alunite was under construction in Utah. It is hoped that commercial production may cheapen estimated costs of extracting metal from this material. Scrap aluminum and tailings from treatment plants are also available for emergency supplies.

The utilization of Northwest clays as a possible source of alumina for making aluminum is being carefully investigated. Clays from near Spokane and Castle Rock, Washington, and Molalla and Cottage Grove, Oregon, have been tested. Since the Northwest aluminum plants will consume over one billion pounds of alumina in making their estimated annual output of 600,000,000 pounds of aluminum, there is an immediate market available if efficient processes for processing clays can be developed.

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MAGNESIUM

Magnesium is the newest metal to attain large scale production. Although not included as a strategic ma-

terial on early lists prepared by Government agencies it later became recognized as an essential in the defense program and by 1941 the Government assumed an absolute priority over all magnesium production for the duration of the war. As a substitute for aluminum, in addition to many uses of its own in making strong, light alloys for aircraft and so forth, the demand for magnesium is such that several huge new plants have been constructed by our Government to supply this strategic essential. Magnesium is one of the common constituents of the earth's crust and is present in a large majority of rocks. However, extraction of the metal from lavas and other igneous rocks is too expensive and difficutl for commercial production. Magnesium is being made from a sedimentary rock called dolomite. Magnesium salts, found in abundance in ocean water and many alkaline lakes, have been used as sources of the metal. Minerals from which magnesium is extracted include magnesite (magnesium carbonate), dolomite (magnesium-calcium carbonate), and brucite (magnesium hydrate). Formerly magnesium wire, ribbon, and powder were used in chemistry and for flashlight powder or pyrotechnics. The extraction of magsium metal in the United States began in 1918. The demand for the metal was small until it was learned that Germany was using nearly 20,000 tons annually (one-half the world's output in 1940) for the manufacture of aircraft parts, bombs, and other military equipment.

Until 1941 all the magnesium produced in the United States was made by the Dow Chemical Company at Midland, Michigan, from brines pumped from the ground. Here the bromine and the calcium and sodium salts are removed by evaporation, filtration, and precipitation. From the magnesium chloride residue the metal is recovered by electrolysis. In 1941 the Dow Company began production of magnesium in Texas, from sea water, by an electrolytic process. Michigan brines contain 0.8 per cent magnesium and sea water 0.12 per cent magnesium. At Freeport, Texas, lime from oyster shells is used to precipitate the magnesium in the form of milk of magnesia (magnesium hydroxide). This is changed by hydrochloric acid to magnesium chloride from which the metal is recovered by electrolysis. A small magnesium plant has been operated at Grays Harbor.

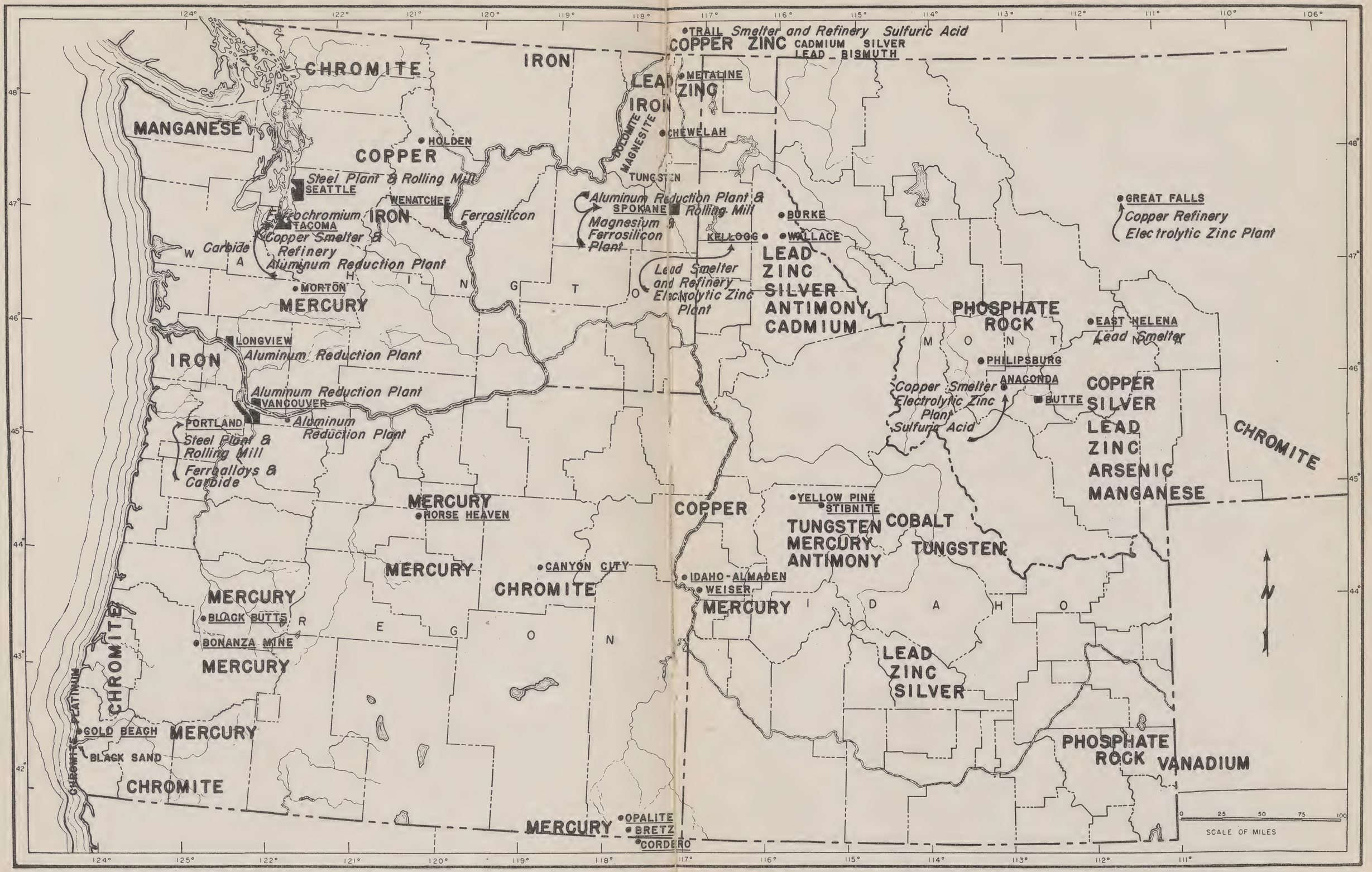
Other plants, including one in the Pacific Northwest, have been built to manufacture magnesium from its ores: magnesite, dolomite, and brucite. Various smelting methods are used in the plants. Some have an electric furnace where glowing coke takes the oxygen from the ore, forming carbon monoxide, and the magnesium is vaporized. This vapor must instantly be cooled and condensed to dust by some reducing gas like natural gas or hydrogen or the metal would unite with the oxygen of the carbon monoxide and revert to magnesium oxide. A new process uses ferro-silicon as the reducer to remove the oxygen, in furnaces heated by electricity, gas, or coal. The magnesium condenses in cooler parts of the furnace, after volatilization. Other methods are being tried in small pilot plants and may be applied commercially. For the armament program the United States Government expects a production of 300,000,000 to 400,000,000 pounds of magnesium in 1942, and double that figure by 1943. For comparison the domestic output of magnesium in 1940 was 12,500,000 pounds and only half that in 1938 and 1939.

The greatest consumption of magnesium is: (1) as an alloying constituent in aluminum sheet, tubing, structural shapes and castings used in aircraft construction; and (2) as magnesium alloyed with a small amount of aluminum, used in making castings and forgings for aircraft engine parts and some other structural parts of the aircraft. In 1940 the aircraft industry consumed 75% of the magnesium production. Magnesium is a tenth lighter than aluminum and fully as strong. The metal can be used in automobile and truck parts and alloys for many purposes, including tools and dies. Magnesium is often mixed with iron and zinc as well as aluminum. Magnesium can serve as a deoxidizer to remove residues of oxygen from iron used to make steel. Other uses are for incendiary bombs, in which even the casing burns, for flares and other munitions. While magnesium ribbon burns like celluloid, thicker masses of the metal requires much heat for combustion. Likely after the war magne-

STRATEGIC MINERALS

THE PACIFIC NORTHWEST

STRATEGIC MINERALS OF THE PACIFIC NORTHWEST



sium will be used for kitchenware and a great variety of other purposes.

There is an abundance of source material from which magnesium can be made. That in the ocean is inexhaustible and the quantity in brines and the rocks reaches enormous figures. In the coming years many uses will be discovered for magnesium and it will likely become one of the most widely produced metals in the world. In the Pacific Northwest near Chewelah in Stevens County, Washington, are the world's largest known beds of magnesite. Some magnesite has been located in southwest Oregon. Dolomite (calcium-magnesium carbonate) occurs in northeast Washington, the mountains of Montana, and southeast Idaho. There is also a possibility of recovering magnesium from olivine of which large tonnages are known in the Puget Sound area.

While magnesite may attain future importance as an ore of magnesium its use to the present has been for the manufacture of refractory materials, like magnesite brick, furnace linings and heat insulators. At Chewelah the magnesite is heated in rotary kilns to drive off carbon dioxide and change the material to magnesia (magnesium oxide) that is shipped east to be made into brick for the steel mills. Magnesite can also be used for tile, stucco, sound insulation, fire retarding paint, and other construction materials. The stimulus for the development of the Stevens County magnesite came in World War One when the European sources that had supplied most of the demands of the United States were cut off. The Chewelah operations ceased for a time after the war when imported magnesite was available at prices below cost of production and freight from Washington to market. Later a moderate tariff permitted operations of domestic magnesite producers, although much magnesite was still imported. World War Two and the needs of the steel mills working for national defense have again caused great activity in producing magnesite in northeast Washington and a record production has been attained.

Some refractories are made from dolomite as the raw material. Magnesium salts are used in medicine, certain cements, sizing and dyeing, textiles, tanning leather, in the refining of sugar, in chemical laboratoies, and so forth.

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NON-FERROUS METALS

ANTIMONY

Antimony, while generally described as a minor metal, has several military uses and is one of the most important strategic metals. Antimony metal by itself has few uses, the chief use being for making ornamental castings. Its use here is due to the fact the metal is ordinarily cheap in price. Salts of antimony are used in safety matches, in one process of making red rubber, in paint pigments, and in coloring glass. The most important uses of antimony are in alloys. Usually three-fourths of the consumption of the metal is used to harden lead. The hard lead contains from 4 to 12% of antimony and is used for bullets, storage battery plates, telephone cables, solders, and many other things. Much antimony also is required in type metal, not only for hardening but to counteract expansion of lead with increased heat—which would cause pure lead type to swell and make casting of linotype slugs difficult. Antimony has the peculiar property of contracting with a rise in temperature and in that respect it differs from almost all other elements—bismuth being the only other common metal having the same property. Pewter, made of lead, tin, and antimony, is another common alloy. For war requirements antimony is used to harden the bullets and shrapnel. It is in the priming mixture for cartridge caps. Also shrapnel shells contain antimony sulfide that gives a white smoke on exploding—making it possible for the place of the explosion to be located, and for corrections to be made for improving the accuracy of fire.

Usually the high cost of mining precludes the operation of antimony mines in the United States in competition with foreign low-cost producers. In World War I the price jumped from 6 to 44 cents a pound and stimulated by the high price in 1915 this country produced 2,100 tons of antimony. However, the high price also caused other nations to increase production and then the price declined. When it fell to about 12 cents a pound domestic mines were mostly closed.

The largest supplies of antimony come from China, Mexico, and Bolivia. Yugoslavia has the largest output in Europe and this helps fill the needs of Germany. Exports from China stopped in 1942 as a result of the war with Japan and the loss of the Burma Road. In 1940 antimony production of the United States was only 412 tons and the most in any recent year was 1056 tons in 1937. In the past most of the antimony came as a by-product from mines important for other metals. Some antimony is recovered as a by-product of smelting operations notably at Trail, British Columbia. A large tonnage (11,421 tons in 1940) of secondary antimony is recovered from storage batteries and other scrap.

The largest antimony mines in the country have recently been developed at Stibnite in Valley County, Idaho. Stibnite (antimony sulfide) is the common ore after which the settlement was named. Development was rapid during 1941 and 1942 and production of antimony was about 1,000 tons a year from 60,000 to 70,000 tons of ore treated. A further increase in output is planned. The Stibnite (Yellow Pine) district will go far towards replacing the supply of antimony usually imported from China. Several million tons of ore estimated to contain thousands of tons of antimony has been developed at Stibnite. The ore now used averages about 2 to 3 per cent antimony. The mines are near the rugged Thunder Mountain area, but an improved road is being constructed to a railroad shipping point which will be helpful to the operations. At Kellogg the Bunker Hill and Sullivan smelter has built an electric furnace to produce antimony by treating antimonial concentrates from the Sunshine mine near Kellogg.

In Montana several shipments of antimony ore have been made from two mines in Prospect Creek in Sanders County about 25 miles from Thompson Falls. Prospecting was done in Jackson and Baker counties, Oregon, in 1940 but no production was recorded. Antimony ore has been found in the central Cascades of Washington and in the Okanogan Highlands, but production has been small. A mill was constructed in 1939 at the Cleveland mine in southern Stevens County, Washington ,to operate on ore containing antimony, lead, and zinc. Nevada is reported to have twenty producers of antimony, but most of them are small. In Alaska, the Stampede mine near Mount McKinley National Park produced 2400 tons of ore containing 1273 tons of antimony worth about $360,000, in the five years from 1937 to 1941. There are other prospects in the vicinity.

Two antimony smelters exist in the United States. The largest, at Laredo, Texas, operates mainly on Mexican ore. In addition the metal is recovered as a by-product from many other smelters.

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ARSENIC

Arsenic is an essential mineral but the supply appears adequate for demands. Nearly all the arsenic in the United States is recovered in the form of white arsenic (arsenic trioxide) as the by-product of the smelting or refining of complex copper, lead, zinc, and gold ores. The leading producers are the Anaconda Copper Mining Company, American Smelting and Refining Company, and the United States Smelting, Refining and Mining Company. The total white arsenic production in 1940 amounted to 18,241 tons. In the Northwest, arsenic is a common con-

stituent of ores at Butte, and Montana is the leading state in output of arsenic, about 300 tons per month coming from the Anaconda smelter. Ores of other districts in Montana that contain arsenic include Jardine, Philipsburg and the Helena district. Ores in central Idaho, the northern Cascades in Washington, and in Grant and Jackson counties, Oregon, are arsenic bearing. There are no arsenic mines, the by-product sources being adequate to supply the demand. The United States is the largest producer and consumer of arsenic in the world. Usually we import arsenic from Mexico and Sweden but the last source is shut off on account of the war.

Arsenic metal is used to harden lead, copper, and zinc, and in certain alloys, like white bearing metals. The greatest demand for arsenic is in compounds used as insecticides. The chief arsenical insecticides are lead arsenate (60,000,000 pounds in 1940), calcium arsenate (40,000,000 pounds), sodium arsenite, Paris green (2,000,000 pounds), and London purple. Calcium arsenate is used chiefly against the cotton boll weevil. Lead arsenate is used to combat various insect pests—in spray in the case of codling moths in apple orchards and gypsy moths in shade trees, in mash for mormon crickets and grasshoppers and in soil infested with Japanese beetles. Other examples include arsenic compounds used for killing weeds, and arsenical drugs for the treatment of syphilis. In war, arsenic is used to harden lead bullets and can be used for chemical warfare materials if such becomes necessary. Any large increase in demand for civilian and military needs could be supplied by constructing additional plants to recover arsenic from the abundant supply of arsenic bearing ores from many of which the metal now goes to waste.

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BISMUTH

Some bismuth is consumed for military needs, chiefly in alloys and medicine. The United States produces adequate amounts of bismuth for its needs. The metal comes chiefly as a by-product from smelting lead, zinc, and silver ores. In the Northwest, smelters at Anaconda, Montana, Trail, British Columbia, and sometimes at Kellogg, Idaho, recover bismuth. In addition bismuth ore is recovered from concentrates in a mill near Dillon, Montana. Peru and Mexico with the United States and Canada supply the bulk of the bismuth output, but the metal is produced by a number of countries including several in Europe. Bismuth occurs associated with ores of various metals in Montana, Idaho, and Stevens County, Washington.

Bismuth contracts on being heated in contrast to most metals which expand with heat. By combining bismuth with lead or other elements a non-shrinking or non-expanding alloy can be made. Bismuth has a low melting point, which is an advantage in making fusible alloys. Bismuth alloys are widely used in the manufacture of machine tools and dies, airplanes, and automobiles. "Carrobend," a new alloy of bismuth, lead, tin, and cadmium, is used for bending thin-walled aluminum alloy for oil and gas tubes in airplanes. The molten bismuth alloy when poured into tubing can be squeezed out of any holes that may be present and also since it expands slightly on solidifying any weak seams will be opened. The alloy can be reclaimed from the tube after bending by means of steam since its melting point is lower than that of boiling water. Bismuth is used for centering machine tool bearings and die fixtures. Bismuth compounds are consumed extensively for medicines for indigestion and blood diseases, for salves, and so forth.

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CADMIUM

Cadmium resembles antimony in many of its properties. The chief use is in electroplating and here the metal has some strategic significance. In the national defense program cadmium plated goods are used for bolts and nuts in aircraft, for wire cloth, and shoe nails. Cadmium is also used for bearings, in red and yellow pigments for paint, including some lipstick. It is

present in various alloys. Cadmium does not easily rust, corrode, or peel off and so can be substituted for more valuable chromium or nickel in the electroplating industry. An alloy of copper and cadmium forms a superior transmission wire for telegraph, telephone, and power lines. The alloy lasts much longer for trolley wire than pure copper. Cadmium electric storage battery plates deteriorate less than the usual lead plates. An alloy of lead and cadmium makes an excellent bearing material with a low co-efficient of friction. Cadmium is used with bismuth or lead, and with either of these metals and tin to form a fusible alloy for fuses and fire extinguishing devices. Cadmium can be used for electric vapor lamps, a spark-emitting alloy for cigaret lighters, and so forth.

Consumption in the United States in 1940 reached nearly 6,700,000 pounds—a new record which went still higher in 1941. Most of the cadmium is supplied from producers in the United States. There are no cadmium mines; the metal is entirely a by-product from smelters. Cadmium is most common in zinc ores and is recovered from their residues left after treatment of ore in electrolytic zinc plants at Trail, British Columbia, Kellogg, Idaho, and Great Falls, Montana. The proportion of the cadmium recvered in the purification of the residues in the leach plants is one ton of the metal to about 200 or 300 tons of zinc. The Great Falls plant, with an output of 1,307,000 pounds in 1940, is probably the largest producer of cadmium in the world. A smelter at Midvale, Utah, recovers cadmium from its lead flue dust that collects before the material escapes up the smokestack. Flue dust from Mexico containing cadmium is treated in the United States. Germany, Belgium, Norway, and Poland are producers in Europe. Japan has little cadmium.

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COPPER

Until war began copper, iron, lead, and zinc were recognized as essential preparedness materials, but the domestic supply was so large that they were not classified as critical. However, armaments require such great amounts of the four metals mentioned, along with others, that these are now included among the strategic materials. The United States produces about one-third of the world's copper, one-fourth of the lead, and over one-fourth of the zinc. Yet so enormous is the demand, that imports of all three of these metals were needed in 1942 in addition to the domestic supply.

Copper is imported chiefly from Chile and Mexico. The total output of the United States in 1940 was 1.818,167,516 pounds, and probably exceeded two billion pounds in 1941. Arizona and Utah together produced nearly 60% of the total, and Montana about 14 per cent. Washington and Idaho stood eighth and tenth respectively among the states in their copper production. The Northwest as a whole produces about one-sixth of the Nation's copper. Most of this is from Butte. In second place is Holden, Washington, near the head of Lake Chelan. There is some copper produced in Okanogan and Stevens counties, Washington. The Coeur d'Alene District is the most important producer in Idaho. A small amount of copper, mostly a by-product from gold mines, comes from the Blue-Wallowa Mountains in Oregon. Copper occurrences are numerous and it is likely that some new copper mines will be opened in the future. For example, the Holden mine in Washington. with an output of 18,576,000 pounds of copper and 51,444 ounces of gold in 1940. together worth four million dollars, has been in large scale operation only five years. Butte has produced more copper than any other district in the country and today is exceeded in annual output only by the immense open cut mining operations at Bingham. Utah. There are several districts that divide the output of Arizona and no district in that state equals Butte or Bingham. Reserves of copper are large in the Northwest and an important share of the supply of the metal will continue to come from this region for many years.

Copper has so many uses that it is difficult to enumerate all of them. The most important use is as a conductor of electricity, and all sorts of electrical equipment contain copper wire. An-

other large use is in alloys. Brass, a mixture of copper and zinc, is used for countless objects, including cartridge and cannon shells. Bronze and gun-metal are alloys of copper, tin, and zinc. Electroplates and electrotype, plumbing and some roofing are among diverse materials that contain copper. Copper salts are used in copper plating, certain sprays, wet cells for railroad signals, pigments, calico printing, and so forth. Copper or copper plated soft steel is preferred to iron for cartridge shells because the copper expands quickly and makes a tight fit in the rifle barrel, giving maximum velocity to the bullet. Copper also contracts quickly, which allows a rapid release of the shell.

Northwest copper ores are smelted at Anaconda and Great Falls in Montana; Tacoma, Washington; Trail, British Columbia; and Salt Lake City, Utah. Low grade copper ores are concentrated either by gravity or by oil flotation before shipment to a smelter, thereby eliminating waste rock and reducing weight and freight cost. A by product of the Anaconda and Trail smelters is sulfuric acid. This is used for many purposes, including the making of super-phosphate fertilizer and explosives. Bismuth, arsenic, lead, zinc, cadmium, silver, and gold are by-product metals from copper ores that come from the Butte mines.

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LEAD

Lead has many direct and indirect war uses. The United States output (433,000 tons in 1940) is between one-fourth and one-fifth that of the entire world. In addition 250,000 tons of secondary lead are recovered annually. Foreign ores, mainly Mexican, smelted in this country add about 100,000 tons. Usually the United States is an exporter of lead products but in 1940 as a result of demands for the defense program our country imported, mostly from Canada and Latin America, about 150,000 tons of lead in excess of exports. Thus we are now consuming at least one-third and perhaps 40% of the world's lead, yet more is needed. Some of the increased consumption of lead since 1940 results from the shortage of other metals that has caused a search for substitutes by consumers. Among such examples was the substitution of lead for tin in collapsible tubes.

About one-fourth of the domestic lead is ordinarily used for paint pigments. In this form the metal is lost forever. Most other uses of lead permit its ultimate recovery, sometimes as scrap or secondary lead. Lead pipes are used in plumbing and for telephone and telegraph cables. Lead goes into storage batteries for motor vehicles and submarines, into shot, bullets and shrapnel, roofing, lining for sulfuric acid vats, sheet lead for wrapping products, and into many alloys. Among the uses of lead alloys are battery plates and type metal (lead and antimony), solder (lead and tin), fusible metal (lead, bismuth, and tin), for automatic fire fighting devices, bearing metal, and many others. Another use is for tetraethyl lead for the best aviation and motor gasoline. Lead is also consumed in the manufacture of high grade glass.

The leading lead mining state is Missouri. In easy second place is Idaho—due to the large output of the Coeur d'Alene District, which ordinarily mines over one-fifth of the lead of the nation. Utah stands third among the states. Other northwest lead producers are Butte (where the metal is a by-product), central and western Montana, and the Warm Springs district in south-central Idaho. There are many small producers in the northeast corner of Washington and in most of the mountain counties of Idaho.

Lead smelters that handle Northwest ores are located at Kellogg, Idaho; Trail, British Columbia; East Helena, Montana; and Salt Lake City, Utah.

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MERCURY (QUICKSILVER)

Mercury, also called quicksilver because of its silvery-white liquid quality, is a strategic metal of high importance. The United States consumes about one-fourth of the world's mercury output. Ordinarily 35% of the domestic demands are supplied by imports, mostly from Italy and Spain, the largest producers, and from Mexico. While some mercury is still imported from Spain for the most part our country had to depend on increased output from domestic mines and on imports from Mexico. Substantial increase in the price of mercury permitted operation of low-grade and high-cost mines in the United States that usually cannot run at a profit. Also discovery of new deposits was encouraged and several new mines in the Northwest were opened after the preparedness program began.

In the 1870's and early 80's the United States supplied over half the mercury in the world. Since that time our output has varied greatly, but has averaged about one-sixth of the world's production. Stimulated by high prices, the domestic mercury production averaged over 1100 tons annually during World War I. After the war the output dropped greatly. In late years about two-thirds of our consumption has come from domestic sources.

Mercury, in the form of fulminating mercury, a nitrate salt of the metal, is used as detonator in both munitions of war and for works of peace like mine and road blasting. Hunting ammunition consumes considerable quantities too. The metallic mercury is used in thermometers, barometers, vacuum pumps, mercury vapor lamps, rectifiers, switches for electric signs and traffic control lights, and many other purposes including the newly developed mercury vapor turbine. In the last instance mercury gas is substituted for steam in operation of the engine with the mercury being condensed and used over and over. Considerable gold is recovered from placers and free milling ore by passing the material over mercury and forming an amalgam. By heating the amalgam and condensing the mercury that boils off most of the metal is recovered for use again.

Mercury compounds are used in vermillion paint, antifouling paint for the bottoms of ships, antiseptics and other drugs, dental amalgam, seed disinfection, and for the caps used in blasting and exploding ammunition.

Deposits of mercury ore usually occur near hot springs and lavas in regions of geologically recent volcanic activity. Fumes coming from hot and perhaps molten material contained mercury which condensed around vents— often under a capping of impervious rock. Here veinlets and irregular seams of cinnabar (mercury sulfide) impregnate the porous rocks and form the ore deposits.

Mercury is recovered from cinnabar by a distillation process. Mercury is driven off from the ore in a furnace and the resulting gas condenses to the liquid in flues that are cooled to promote condensation. Workable mercury ores often contain under one per cent of metal and have been worked for as little as 1 or 2 pounds of mercury per ton. Mines of such low grade ore can operate only in times of high prices. Mercury is marketed in "flasks" of iron, that contain 76 pounds of the metal.

In the United States, California has been the leading producer since the middle of the last century. The ore there occurs chiefly in the Coast Ranges. Oregon, in the Northwest, ranks next after California in mercury output, while some production has come from Idaho and Washington. Other states noted for mercury production are Texas, Nevada, Arkansas, Arizona, and sometimes Utah and Alaska.

Oregon mercury ores occur chiefly in the western foothills of the Cascades, in the Klamath Mountains, in southeast Malheur County and in the Ochoco Mountains in the central part of the state. The Bonanza mine in Douglas County is usually the largest producer

in Oregon. Other large mines are the Bretz and Opalite in Malheur, the Horse Heaven in Jefferson and the Black Butte in Lane County. Twelve properties are active in Crook County. Other producers are in Clackamas, Jackson, and Lake counties. In all there were 23 known producers of mercury in Oregon in 1942.

The mercury of Idaho has nearly all come from the Idaho Almaden mine seventeen miles west of Weiser in Washington County. Production began in this mine in 1939, and by the next year it ranked seventh among the mercury mines in the country. By the end of 1942 the known ore reserves were worked out and operations ceased. This is a good example of the notoriously short life of many mercury properties. Mercury ore also occurs in the Yellow Pine District of Valley County and in Cassia County, Idaho, but production has been inconsiderable. The state of Washington output has come from near Morton in Lewis County but these mines were closed in 1942. The largest mercury production in British Columbia comes from near Fort St. James in the north-central part and from deposits in the southern part of the province that began to produce in 1940.

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PLATINUM AND ALLIED METALS

Plainum has a number of chemical and industrial uses of high value in both peace and war. Since the United States is a large consumer and small producer, platinum may be ranked as a critical metal from the standpoint of national defense. Fortunately Canada is the leading producer and can supply much of our needs. Several other rare metals closely resemble platinum in their properties and for most purposes are not distinguishable from it. Sometimes the addition of one or more of these rare metals improves the properties of platinum. The metals resembling platinum are osmium, palladium, iridium, ruthenium, and rhodium. Generally osmium and iridium are classed together as osmiridium.

Previous to World War I, Russia supplied the larger part of the world's platinum and Colombia most of the rest. When the Russian supply was no longer obtainable the price of platinum soared until it was many times that of gold. The result was intense search for new sources of platinum and several such were developed. Now more than half of the output of platinum and allied metals comes from Canada, mostly as a by-product from the nickel-copper ores of Sudbury, Ontario. Russia produces about one-fifth of the world output and the balance is mainly from the Union of South Africa, Colombia and the United States.

High prices for platinum also gave an economic stimulus to scientific research on substitutes for the rare metal. Among the substitutes is that of fused silica for the acid stills and dishes once made of platinum because the metal will not react with common acids. Formerly platinum wire was used as a lead-in through the glass in electric light globes as it has the same coefficient of expansion with heat as glass. Discovery of an alloy of nickel and iron that had the same expansion rate as glass has led to the complete replacement of platinum for this purpose. Tungsten has largely replaced platinum for magneto points. A number of

alloys, often containing chromium as one constituent, have been invented as substitutes for platinum in much of the scientific apparatus. In the chemical industry platinum is an excellent catalyst for certain reactions—like those of making ammonia from nitrogen and hydrogen and of changing ammonia to nitric acid. Formerly platinum was used as the catalyst in the manufacture of sulfuric acid by the contact process, but for this purpose it has been largely replaced by a cheaper substance, vanadium oxide.

Platinum and its companion metals are used in jewelry and dentistry. Substitution of gold or some other material for platinum could be made in both of these cases. Platinum is required in certain places in the electrical industry, where it is used in X-ray tubes, lead-in connections, contact points, electrodes, radio tubes, magnetos, etc. Platinum is a rather soft metal and for many purposes the addition of iridium to harden it is desirable. For certain purposes gold, nickel, copper, palladium or osmiridium may be added to the platinum.

A most desirable property of platinum is that it will not react with the usual acids. Like gold it occurs in the native state. Platinum is associated in nature only with heavy, dark, igneous rocks, but is found in such tiny quantities therein that rock containing platinum can seldom if ever be worked for the metal. Sometimes platinum is found in veins with gold or other metals. As mentioned, the Canadian production is mostly from nickel-copper ores. Being heavy and insoluble platinum often collects in placers when rock containing the metal is subjected to erosion. The Russian and Colombian output is from placers. Production of platinum in the United States had never exceeded a few thousand ounces, and was mostly recovered as a by-product in the refining of other metals until 1934, in which year placers at Goodnews in southwestern Alaska began to operate. Since 1938 the Goodnews district has produced platinum and allied metals worth over a million dollars annually, and accounted for about three-fourths of the United States output of approximately 40,000 ounces per year.

In the Pacific Northwest there is a small production of platinum (20 ounces in 1940) from beach placers of black sand near Cape Blanco on the coast of southwestern Oregon. Thirty ounces of platinum were recovered by a gold dredge operating in Lewis and Clark County in Montana. About 1,200 ounces are recovered by gold dredges in California and about 8,000 ounces of platinum are secured annually as a by-product of the refining of gold and copper ores.

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SILVER

Silver is not usually considered an essential or strategic material. However, beginning in 1942 silver was substituted for copper in some electrical work. Also silver might be used instead of tin for the lining of "tin" cans. The amount of silver required for covering sheet iron in a can is small. While it would cost more than tin, if the latter is unobtainable silver could be used. Silver is a better conductor of electricity than copper. It can be drawn easily into wire or rolled into thin sheets. Except for its cost it would be an excellent substitute for many uses of copper and tin. The gorvenment has in storage millions of ounces of silver that can be used as an emergency substitute. Several carloads of silver have been used for the big bus-bars on the electrical units of aluminum and magnesium plants in the Northwest. Such silver has been "borrowed" for the duration and will be returned to the government for storage after the war. New silver mined in the United States about equals the demand. The largest consumer is the photographic and motion picture industry. Silver salts are affected by light and so are used on camera and picture film. Silver is used also for silverware, coin-

age, and a little in medicine.

The largest silver mine in the United States is the Sunshine in the Coeur d'Alene district of Idaho. All of the lead and zinc mines of this district also produce silver. Most of the silver produced in the nation is recovered as a by-product. It comes from many gold mines, from the copper mines of Butte, and from lead and zinc mines in Idaho and Utah. Idaho ranks first among the states for silver, Montana is second and Utah is third. Washington is a minor producer of silver as a by-product from copper and gold ores in Chelan Couunty, zinc ores in Pend Oreille County and gold ores in Ferry County. The Pacific Northwest produced 43% of the Nation's silver (70,000,000 ounces) in 1940.

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TIN

Tin is an excellent example of a metal whose deposits are unevenly distributed over the earth. Nickel and molybdenum also occur very unevenly, but for nickel the United States can import its needs from a closeby source in Canada, and as to molybdenum we produce most of the world's supply anyway. However, nature forgot the United States when deposits of tin were made and our known resources of this essential metal are negligible. Tin occurs only in association with granitic rocks and is commonly found in veins or in dikes of a coarse rock called pegmatite. The deposits of tin in Cornwall have been mined for 4,000 years, and mines there that had been closed for many years because of high costs were being reopened in 1942 to help meet strategic needs of the United Nations. The largest production of tin comes from the Malay Peninsula and the Netherlands East Indies. Here the ore is recovered almost entirely from placers and is called alluvial tin. The ore of tin is a heavy oxide called cassiterite. This mineral is insoluble in water, and when tin veins are eroded by water the ore fragments collect down stream in beds of gravel and sand to form tin placers. Bolivia, also a large producer, has been the chief source of supply to the United States since Malaya was overrun by the Japanese. Tin also comes from Africa, being produced chiefly in Nigeria and the Belgian Congo.

The only tin production in the United States in recent years has been from placers in the Seward Peninsula in Alaska. In 1940 this amounted to 44 tons and in 1937 to 168 tons. By comparison world production in 1940 was 231,700 tons so that the output of Alaska has no significance. In Alaska some other tin occurrences have been found northwest of Mount McKinley. The Black Hills of South Dakota have some tin ore and much time and money was spent on development of mines there, but the deposits were low grade and expensive to operate and the production of the tin never proved profitable. However, operation of mines there for the "duration" is being considered.

In the Pacific Northwest no commercial tin deposits have yet beeen developed. Tin ore is reported at Silver Hill south of Spokane, in the northern Cascades of Washington, Baker County, Oregon, and in Custer, Lemhi, and Owyhee counties, Idaho. In Montana tin has been reported from certain ores at Butte and placer tin has been found on Big Prickly Pear Creek and in the Bitterroot Mountains. Alluvial tin has also been located in Nevada but the amount available has not been determined. While development of any tin prospect would appear to be justified because of the shortage of this essential element, yet it seems unlikely from present knowledge that any large reserves of tin will be found in the Pacific Northwest.

Tin is mainly used as a coating on sheet iron or soft steel to make tin plate. This is used for cans, roofing, tinware, and so forth. Tin is also used to make tin foil for wrapping foods, candy, tobacco, etc.; for the collapsible tubes for toothpaste, shaving soap, salve, and other things. Tin is included in several alloys. Solder, babbitt (used for machine bearings), and bronze all

contain tin. Tin salts are used in the weightiing of silk cloth.

While galvanized iron (sheet iron covered with zinc) can replace tin plate for some uses, it is impossible to substitute zinc for tin in tinplate used for canning foods, which constitute the largest single use for tin, since zinc is soluble and forms a poisonous compound with most vegetable and fruit juices. However, glass and paper containers are being substituted for tin, and waxed paper, cellophane, and lead or aluminum foil for tinfoil. For other than food products enamel coatings can replace tin to some extent. Also silver could be used for metal can coverings although the cost would be higher than for tin. Progress is also being made in the recovery of secondary tin from the tin cans of city dumps, from collapsible tubes and the like. Dehydrated (dried) foods are a likely substitute for some of the canned article for the "duration."

Smelting of tin has always been done abroad, mostly in Wales and at Singapore. In World War I a tin smelter, built in New Jersey to process Bolivian ore, was never operated. Again in World War II shipments of ore to England and Wales and of block tin back to the United States were endangered by the submarine menace. The United States Government has contracted for most of the Bolivian output of tin ore and has erected a smelter on the coast of Texas. Here will be handled, at least for the "duration," much of the exports of tin ore from Bolivia that formerly went to Europe.

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TITANIUM

Titanium has uses that cause it to be classified as a critical mineral for national defense. Titanium minerals are very common and are constituents of almost all igneous rocks and of sediments derived therefrom. While titanium occurs in numerous minerals it is recovered mainly from the minerals ilmenite (iron-titanium oxide) and rutile (titanium oxide). Virginia, California, and other states mine titanium ores but much of the supply is ordinarily imported—on the most part from Australia, Brazil, India, Malaya, and Norway. Titanic iron ore occurrences are fairly common in the United States, including northern Montana, in the northern Cascades and elsewhere in the Northwest. A small deposit containing 25% titanium occurs in western Washington and it is possible that larger deposits may be discovered here or elsewhere in the region.

Titanium compounds are used for pigments in paint, in paper, rubber, cosmetics, rayon and other products. Rutile is an excellent flux and is used for coating welding rods for the electric arc. Titanium compounds are also used in dyeing, in glazing porcelain, as catalysts in chemical reactions, and for smoke screens in warfare. Some titanium alloys are also made. Synthetic titanium carbide, nitride and silicide are used for machine tools and are among the hardest artificial products made by man.

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ZINC

Zinc is an essential war material. While the United States leads the world in zinc production, the demands of the armed forces and industry are so great that a shortage in zinc threatens. The smelter output of zinc in the United States in 1940 was 725,000 tons, 50,000 tons of secondary or scrap zinc and also 85,000 tons from Mexican ores. Yet this 725,000 tons was hardly sufficient for our needs while the War Production Board requests nearly 1,000,000 tons annually for the duration. The world zinc production in 1939 was 1,635,000 tons; in that year the Uniaed States mined 29% of the world's output, while in 1940 we probably produced close to 37%. Leading foreign producers are Belgium, Poland and Ger-

many. The Axis powers have adequate supplies of zinc. Mexico, Canada and Australia are also important for the metal. In the United States the Oklahoma-Kansas-Missouri district easily leads, with New Jersey in second place. Idaho is third among the states. The Idaho zinc comes mainly from the Coeur d'Alene district with most of the balance from Warm Springs in Blaine County. Montana stood fifth among the states in 1940, with most of its zinc coming from Butte, and with other producing areas near Philipsburg, Neihart and Basin. Metaline in northeast Washington stands about tenth among the zinc mining districts in the United States. The four northwest states produced 15% of the zinc of the nation in 1940. Probably the largest zinc mine in the world is at Kimberley, British Columbia, whose ores are smelted at Trail.

Zinc is recovered from its ores in various ways. If zinc ore is pure it may be put in retorts where the zinc is first vaporized and then condensed to dust in a condenser. The dust is then melted to make metallic zinc. In the West, however, ores containing zinc are generally very complex. Lead-zinc-silver ores are common, and in addition gold, antimony, arsenic, copper and other metals may be present. In a lead smelter zinc interferes with the process and the smelter, instead of paying for the zinc, assesses a penalty against the ore that contains it. As a result large reserves of complex zinc ores were unsalable. Finally a "wet" process was invented in which the various metals can be dissolved and then recovered by electrolysis. This discovery was an important one for miners in Idaho and Montana as their worthless ore became highly valuable. Electrolytic zinc plants are operated at Kellogg, Idaho, and at Great Falls and Anaconda, Montana, and are of great value to the Northwest mining industry.

Zinc has numerous uses. The metal is used in galvanizing iron wire and sheet steel. While food products cannot be canned in zinc covered containers, inedible materials like petroleum oils may be kept in cans of galvanized iron. Zinc goes into many alloys, notably brass, bronze and German silver. Zinc is used in dry cells. Zinc compounds are used in making waterproof paint and other pigments, as a wood preservative, in the manufacture of rubber, and for dyeing and coloring yarn and cloth. There is much zinc in automobiles. Some 80,000 tons of zinc per year went into private cars and will now be available for war uses.

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PART TWO...NON-METALS

ABRASIVES

The abrasives, of which large quantities are used for scouring, grinding, sharpening and polishing sometimes occur in nature but others are made artificially. Resources of abrasives are known in the Pacific Northwest but have been but little developed. Western Washington has quarried small amounts of grindstones and from Wilkeson, Pierce County, have come pulpstones used for the great wheels that grind wood into pulp. Garnet suitable for abrasive use occurs in northern Idaho and west of Helena, Montana, and shipments are now being made from Idaho. Sapphires that are used to some extent for abrasive purposes are mined in central and western Montana. Silica and diatomite are

sometimes used for abrasives and large deposits of each are known in the Northwest. Artificial abrasives are imported from the East into the Northwest, but since the raw materials and required cheap electricity are both available it is possible that the manufacture of some of the synthetic product may be done in the region in the near future.

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ASBESTOS

The name asbestos is applied to certain fibrous minerals that can be used for the manufacture of heat and chemical resistant materials. Among the asbestos products are shingles, brake lining, fireproof clothing (used by fire fighters on warships and flame throwmers in the army), fireproof curtains for theaters, and coverings for steampipes and furnaces. Being resistant to chemicals it is used for materials exposed to corrosion. Canada produces about 60% of the world's output of asbestos and so the United States has access to supplies adequate for its needs, although domestic production in our country has always been small. The latter output comes from Arizona, Vermont, and several other states. Asbestos has been found in all the Northwest states but there has been no commercial production. The veins of asbestos usually are in exposures of old metamorphic rocks that have been changed from their original character by being subjected to much heat and pressure. Asbestos occurrences have been described in the Klamath and Blue Mountains in Oregon, the northern Cascades, southwestern Montana, and southeast and east central Idaho. In Gallatin and Madison counties, Montana occurrences are reported of the high grade automobile type of asbestos that is of suitable quality for spinning.

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FLUORSPAR

The mineral fluorite (calcium fluoride) when used commercially is usually called fluorspar. This has been classified as a critical mineral since substantial amounts of fluorspar have been imported, largely from England. The chief domestic production has come from Arizona, Colorado, Tennessee, New Mexico, New Hampshire, northwestern Kentucky and southern Illinois. In the Pacific Northwest there are numerous occurrences of fluorspar in central Idaho. The operators of one such deposit, on Camas Creek in Lemhi County, plan to build a mill in 1943 and have contracted to furnish 10,000 tons of fluorite annually to the government. Fluorspar has also been found in several localities in southwestern Montana and northeastern Washington. In 1916 a small tonnage was reported to have been mined, but not shipped, in Ferry County, Washington. (Burchard, p. 176).

Fluorite is often associated with other minerals, especially calcite, quartz and barite, in veins that sometimes also contain values in metals like zinc, lead and iron. Usually the material requires concentration to prepare the fluorspar for market. The largest use of fluorspar is to add to the limestone used for flux in the basic open-hearth process of steel making. Here it helps make the metal more fluid and tends to carry phosphorus, sulfur and other impurities into the slag. It is also used as a flux in iron and brass foundries. Other uses are in the manufacture of opalescent glass, bathroom ware, enameled ware, and refrigerants and chemicals, such as hydrofluoric acid used for etching glass. Fluorspar may also be used to manufacture the calcium-aluminum fluoride (called cryolite when it occurs in nature) that is required in the electrolytic process of making aluminum. Lenses for certain optical uses are made from large crystals of transparent fluorite.

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MICA

Mica is a highly important nonmetallic strategic material. It is a flexible, transparent mineral that splits easily into thin sheets. It not only has many applications in electrical installations and equipment, but is used extensively for windows in stoves and ovens, gas masks, goggles and other things where a transparent heat resistant material is required. Its electrical uses are many. Mica is a superior material for electrical and heat insulation. It is used in fuses, heating irons, toasters, radio condensers, motors and many other devices. Substitution of porcelain for low grade mica as an insulator is possible and efforts are being made, with prospect of success, to manufacture some synthetic substitute for sheet mica.

About 90% of the world's high grade sheet mica usually comes from British India. Other producers are Madagascar, Brazil, South Africa and Canada. The United States mica output is mainly of lower grade and in smaller sheets than the imported article. However, selected mica from domestic mines is as high in grade as the Indian trimmed mica. Differences in labor costs handicap the United States producer. Essentials like condensers and spark plugs have been made mostly from imported mica, of which the highest quality comes from India. To conserve the supply, built up mica made from small flakes can be used for many purposes (Tyler, 1939). Also mica can be split into sheets only one thousandth of an inch thick for use in household appliances and automobile engines. Proper splitting of mica is of great importance. Probably 100 tons per year of high grade mica would be sufficient to supply our most pressing needs for the material. In the past over a million and a third dollars worth of high grade mica was produced in the Black Hills, but the output has been small in recent years. The fabrication of objects from scrap mica can use much material that would otherwise be wasted.

In the United States mica occurs, besides in the Black Hills of South Dakota, in the Appalachian region, New England and many other places. In the Northwest work has been done on a promising deposit in Latah County, Idaho, from which has come about $100,000 worth of mica (Forrester, 1942, p. 2). Mica occurrences are known in many places in every northwest state but production has been insignificant except in the one case mentioned. Low prices have discouraged development. It is quite possible that commercial mica resources can be found by careful exploration.

A peculiar mica-like mineral called vermiculite is mined near Libby, Montana. On being heated the material expands to many times its original volume. Sold under the name of zonolite, it is used for heat and sound insulation and for other purposse.

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NITRATES

Natural nitrates—the highly important raw materials used in the chemical industry for explosives manufacture and as a source of fertilizer nitrogen—are not mined for themselves in this country, although small deposits, mostly in caves, have been found in Idaho and elsewhere (Mansfield, 1915 and 1932). Chile saltpeter (sodium nitrate) is imported from the deserts of northern Chile. Ammonium sulphate and ammonia gas are produced in large quantities (one and one-half billion pounds annually) as by-products from the coking of coal. About one-fourth of the world's output of nitrogen compounds is now from natural sources—Chile saltpeter and coal—while the balance (three-fourths) is synthetic. In the United States large increases in the manufacture of synthetic compounds of nitrogen have been made in connection with preparedness for war, and the construction of new nitrate plants will cause still further increases. The production of synthetic ammonia from electrolytic hydrogen requires a

large amount of electricity, and such plants are generally located near supplies of cheap hydroelectric power. Another process uses water-gas hydrogen to fix atmospheric nitrogen, and thus substitute coke for electricity. Such a plant requires only a source of cheap coke. The fixation of atmospheric nitrogen by either of these standard processes is an industry that should succeed in the Pacific Northwest. The defense program requires nitrates for military explosives; subsequent peacetime activities will require nitrogen for explosives for construction and mining as well as for fertilizer and chemical manufactures.

The first commercial production of synthetic nitrogen compounds was in 1906 by the cyanamid process. In this case nitrogen is passed over calcium carbide at a temperature of about 1800° F. and they combine to form calcium cyanamid. This may be used directly as a fertilizer. However, it can be converted into ammonia by steam or into various cyanide compounds by other methods.

In 1907 the arc process was invented. This is like artifiical lightning. In nature the high temperature of lightning causes nitrogen and oxygen from the air to combine and then rain dissolves the compound and carries it to earth. Likewise high voltage discharges of electricity in a plant under proper conditions will cause some of the nitrogen and oxygen of the air to combine first to form an oxide of nitrogen, which when absorbed by water produces nitric acid.

The most widely used process was invented last. Hydrogen is produced, either by electrolysis of water, or by passing steam through red hot coke making water gas as a by-product. Nitrogen is then separated from the oxygen of the air, and burned to ammonia. The process of nitrogen fixation requires the use of a catalyst which, by its presence, and under conditions of high temperature and pressure, causes nitrogen and hydrogen gases to combine, forming gaseous ammonia. To make the desired nitrates, the ammonia is oxidized to nitric acid, which in turn, reacts with other chemical materials. Explosives, for example, are made chiefly by nitration of cellulose (nitrocellulose); toluol (trinitrotoluol); glycerine (nitroglycerine); phenol (nitrophenol), etc.

Synthetic nitrogen makes the nation independent of imported supplies of nitrates for munitions, and leading nations, including the United States, have constructed several plants to produce these strategic compounds. One nitrate plant is located in the Puget Sound area and others may be built. Synthetic nitrate plants prefer locations near supplies of cheap hydroelectric power.

Nitrogen compounds have very many uses. First nitrogen is in all organic matter. It is an essential plant food and when added to many soils will increase crop yields. Fertilizer accounts for around 70-80% or more of the nitrates consumed in the United States during peace time. Among industrial uses is that of explosives which consume about 9-10% of the nitrate supply in ordinary times and much more during wars. Nearly all explosives contain nitrogen—for example guncotton, dynamite, T.N.T., gunpowder, smokeless powder, nitroglycerine, cordite and many more. Other industrial uses include: ammonia refrigeration, great numbers of different chemical compounds like plastics, textiles, medicines, and so forth.

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OPTICAL MATERIALS

An exceptionally pure quartz sand is required for making optical glass in addition to other products commonly used in this country. Of most importance in the optical industries is workers having the great skill and experience required. Previous to World War I the United States imported most of its optical glass from Germany. Now adequate amounts are made in our country for essential war purposes although consumption for civilian use is restricted. Precision lenses are required in cameras, range finders, telescopes, periscopes, gun sights, and other instruments for military use. No optical glass is made in the Northwest although the raw materials are available. The use of quartz in radio work will be separately described. (p. 72.)

Certain optical instruments require perfect crystals of calcite (calcium carbonate). Calcite has the valuable property of causing polarization of light. Polarization is the name given to the separation of light into different wave lengths when light rays are passed through calcite crystals. Light will pass through calcite only in one plane so that by placing two calcite crystals called nicols, at right angles, all light could be excluded. By polarization of light glare can be avoided. The addition of a film coat of calcite on camera lenses also decreases surface reflection, increases speed of taking photographs and improves the sharpness of the pictures.

Clear, transparent crystals of calcite are called Iceland spar because formerly that island was the chief source of this material. Recently a deposit of high grade Iceland spar has been developed in New Mexico. Iceland spar occurs near Big Timber, Sweet Grass County, Montana, in veins, two of which are 5 and 7 feet wide. A small amount has been shipped, but that so far discovered was not well adapted for optical use. In 1942 a mine 25 miles northeast of Livingston, Montana, began mining about 500 pounds of optical calcite per day. The material was purchased by the Government for special uses. Not much prospecting has been done for Iceland spar so discoveries of commercial grade of this material are possible somewhere in the Northwest.

As mentioned under fluorite, crystals of this material are sometimes used in optical instruments.

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PHOSPHATES

Phosphorus is one of the three most essential plant foods—the others being potash and nitrates. But in addition to fertilizer requirements, phosphate compounds are used in chemical warfare, in some matches, and many chemical compounds. While closeness to market permits Florida and Tennessee to lead in phosphate rock production the world's largest known deposits are in the Rocky Mountain region, particularly in eastern Idaho, northern Utah, western Wyoming, and southwestern Montana. Here it occurus in beds like coal. Known reserves of high grade phosphate rock in Montana are estimated at 400,000,000 tons. Idaho has reserves of 5,700,000,000 tons, which is claimed to be over one-half of the world's known phosphate resources.

Present processes use sulfuric acid for the manufacture of phosphoric acid and the ordinary and concentrated super-phosphate fertilizers. While the Northwest lacks workable deposits of pure sulfur to make sulphuric acid, most copper, lead, and zinc ores are sulfides. Sulfur dioxide gas is present in the flue gases of smelters that handle these ores, and from this sulfur gas sulfuric acid may be manufactured. At both Trail, British Columbia, and Anaconda, Montana, much of this sulfuric acid is used to convert phosphate rock into super-phosphate fertilizer. The phosphorus in thes natural rock is relatively unavailable as plant food, and the acid treatment converts it to an available form. Sulfuric acid is also used to make some explosives in the Northwest. As new chemical plants build in the Pacific Northwest more sulfuric acid will be needed. Incidentally before the sulfur fumes were removed from the flue gases of smelters much damage was done to vegetation—thus sulfur dioxide which was once a harmful gas is now a useful raw material.

At present about 100,000 tons of phosphate rock are mined in Caribou County in Idaho each year and about 65,000 tons from near Garrison, Montana. Most of the Montana phosphate rock is shipped to Trail, British Columbia. In the future, production may greatly increase. Part of this can be sold locally as it is considered that Northwest farms and orchards will consume increasing amounts of phosphate fertilizer annually as the original fertility of their soil becomes exhausted. The present consumption in Oregon and Washington of ordinary superphosphate, the standard phosphate fertilizer is about 20,000 tons, equiva-

lent to around 8,000 tons of the concentrated superphosphate produced at plants in Anaconda and Trail. At Anaconda vanadium is being recovered from the phosphate rock as a by-product of fertilizer manufacture.

In the Tennessee Valley phosphate fertilizers are being made by electro-thermal methods at a cost equal to or lower than the sulfuric acid process. It seems likely that if the Pacific Northwest phosphates are to be utilized on a large scale some of these new processes will be employed. If costs are low enough such phosphates can be exported to distant world markets. California also offers quite a large market for fertilizer as the state now uses about six times what is consumed annually in Oregon and Washington.

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QUARTZ CRYSTALS

Crystals of quartz (silicon dioxide) are used for the manufacture of irreplaceable radio parts that control the frequency of the radio waves in instruments essential to communication and aircraft guidance. Since our whole supply of suitable crystals has been imported from Brazil this form of quartz is a strategic mineral. However, quartz occurs widely throughout the Pacific Northwest and it is possible that careful search may locate a domestic source of crystals in the region. The use of quartz for optical glass manufacture has been discussed elsewhere (p. —).

In 1939 about 1,500,000 pounds of quartz crystals were produced in Brazil and sold to many different countries. The output in 1942 was probably double the former total and the entire amount was purchased by the United States.

The explanation for the value of quartz in radio work is its piezoelectrical property. This characteristic causes a crystal under pressure to generate an electric polarity or potential. Also if an electrical charge is applied to the quartz in a certain manner its dimensions are changed. A thin plate of quartz mounted between two electrodes will vibrate from 20,000 to 20,000,000 times a second according to its size, shape and thickness. Because of this property quartz-plate oscillators are used for "tuning" radio transmitters and receivers to the same frequency of vibrations and permit reception of radio signals and messages. Radio communicating would be more difficult and less satisfactory by any other known method. Quartz-plate oscillators control the frequencies of transmission from radio stations. They are used also as resonators in cable and telephone work to split the vibration frequencies into "bands"—which permits large numbers of messages to be sent over the same wires at the same time without interference. Quartz crystal plates find use in the devices made for detecting the sounds of submarines and aircraft. Many scientific and precision instruments contain quartz crystal in their construction. Cheap jewelry is often made of quartz. Fused quartz is used as a substitute for the scarce and expensive platinum in laboratory dishes and crucibles that must be unaffected by strong acids.

The section of quartz for radio use is usually about an inch across. If cut through the crystal parallel to its natural faces, the dimensions and vibration rate of the wafer change with the temperature; to avoid this the plate has been enclosed in a mounting whose temperature had to be kept constant. It was discovered that if the section was cut a an angle, the plate was unaffected by temperature and would maintain constant frequency of vibration between temperatures of -30 F. and 60 F. without temperature control. To avoid trouble with moisture the quartz plates are sealed in an air tight holder.

Quartz crystals must be large, optically clear and free of flaws. Such crystals are rare and only a few of those tested meet specifications. Because of the hardness of quartz and the even thinness of the required sections

the cutting of the plates requires great skill and must be done slowly and carefully. The allowable variation in the thickness for radio use is only six ten-millionths of an inch.

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REFRACTORIES

Heat resistant refractory products are needed for firebrick, furnace linings, and heat insulators in iron furnaces, steel mills, electro-metallurgical plants, and for many other industrial uses—many of which have direct application to national defense.

Clay suitable for firebrick and other refractories that can resist a high degree of heat underlie thousands of acres south of Spokane. Much clay has been derived from the weathering of granite that occurs in Mica Peak, Silver Hill and other places. Running water eroded and concentrated the material. This clay is high in alumina and low in iron. It is a possible source of aluminum. A great tonnage is available with little overburden to be removed—which makes for cheap mining.

Magnesite for refractories has been produced at Chewelah, Washington, since World War I, and is discussed under the heading of magnesium.

Diatomite or diatomaceous earth is a siliceous deposit made up of the skeletal remains of tiny plants called diatoms that live both in hot pools and in lakes at ordinary temperatures. Diatomite is white or gray in color and very light in weight. The tests or shells of silica contain air spaces—which makes diatomite a superior material for heat and sound insulation. The material is also used as a filler in rubber, a filter and absorbing medium, and as an abrasive in tooth paste and scouring powders. Nitroglycerine may be absorbed by diatomite to make dynamite, but sawdust is usually used for that purpose. Where diatomite occurs in swamps and lakes in western Washington the material is mixed with organic matter and would require calcining (heating) before use. Large beds of pure diatomite occur in Kittitas, Grant, Yakima, and Adams counties, Washington, and in Lake, Deschutes, Klamath, Crook, Jefferson and other counties in eastern Oregon. Some occurs in the western Snake River Plain of Idaho.

Silica is the chemical name for the silicon oxide that forms quartz and sandstone. To be of economic value, however, it must be pure, accessible and in a usable form. The chief sources are massive quartz veins, quartzite (crystalline sandstone), sandstone, and quartz sand. It is used in ceramics and refractories, in metallurgy, chemical manufactures, glass, in the electrical industry, and for other purposes. Sandstone used for glass making should consist of silica grains and little else, as impurities like iron turn the glass green. Large silica deposits are known near the western Idaho border and in eastern Washington. A silica mine is operating on high class material near Denison thirteen miles north of Spokane. Deposits also occur near King and Pierce counties in western Washington, in central and southwestern Oregon, and southeastern Idaho. Molding sand is required for iron castings but, so far, few deposits of suitable material have been located in the Northwest.

The group of minerals called olivine, from their olive green color, include forsterite (magnesium silicate) and true olivine (iron-magnesium silicate) and can be used for the manufacture of firebrick and furnace linings. In the Northwest olivine is found in an igneous rock called dunite of which large outcrops occur in the Puget Sound region of Washington. Here the two largest deposits are in the Twin Sisters region about ten miles southwest of Mount Baker and on the southeast corner of Cypress Island, one of the San Juan group. On Cypress Island a dome called "Olivine Hill" rises to about 600 feet elevation and covers an area of about one-half by two-thirds of a mile. This deposit could provide a large amount of refractory olivine, estimated at 50,000,000 tons, at tidewater accessible to cheap water transportation. Forsterite bricks are used in the roofs of copper reverberatory smelting furnaces, and in the steel industry for the walls and ports of open-hearth furnaces. The brick are also being used as linings in cement kilns and can be substituted for most uses of magnesite, chromite and other refractories. At present material for forsterite brick comes mainly from the

southern Appalachians but a large industry can be built on the known Northwest olivine occurrences. It is also possible that olivine can serve as an ore of magnesium and experiments for the extraction of the metal from that source are being now carried on.

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STRONTIUM

Strontium is a minor non-metal of military significance. Nitrates, peroxides, and oxalates of strontium are used in tracer bullets for machine guns. National defense requirements have increased consumption of this material greatly, since every fifth bullet used in standard machine guns of aircraft, tanks, and ground forces is a tracer. Strontium compounds are also used in signal lights or fuses on highways, railroads, and ships. "Very" pistols and military flares are other uses. The color of red fuses is due to a strontium salt. Barium salts give a green color and sodium salts a yellow color. Railroads use red fuses for warning to protect a stopped train. Several states require trucks to carry at least two 15-minute red fuses to be ignited in case of accident or repairs. Parachute flares that can be shot from a pistol to a height of 300 to 500 feet are required on lifeboats and small craft. Rockets, giving a shower of red stars, can reach 1000 feet elevation when shot from decks. Several strontium salts are used in fireworks for Fourth of July displays. The common ore of strontium, celestite (strontium sulfate), is used as a filler in colored paints, rubber goods, sealing wax, and other substances, and for the manufacture of strontium compounds.

Strontianite (the carbonate) is used in Europe as a flux in steel making. Strontium hydrate is used in Germany as a desaccharizer (to help precipitate the sugar from sugar beet molasses). Neither of these two uses is common in the United States.

The world supply of celestite has been mined in England and the strontium salts have been made in Germany. The United States has imported its requirements from England and Germany. Except in World War I, little effort was made to develop a domestic supply from resources that are believed to be quite large. Arizona, California, Ohio, and Texas produce strontium ores. In the Northwest a deposit is being worked near La Conner, Skagit County, Washington, and another deposit occurs at the junction of the Skagit River and Ruby Creek in Whatcom County. Reserves at the La Conner deposit are estimated at 10,000 to 12,000 tons. For comparison the United States imported 2750 tons of celestite and strontianide in 1940. Mexico in 1941 shipped 410 tons of strontium minerals to the United States and domestic producers also expanded their output to help meet military needs.

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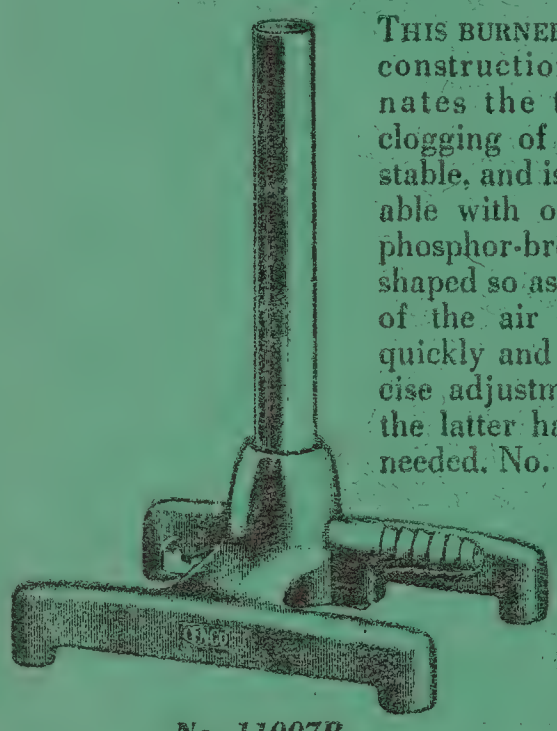

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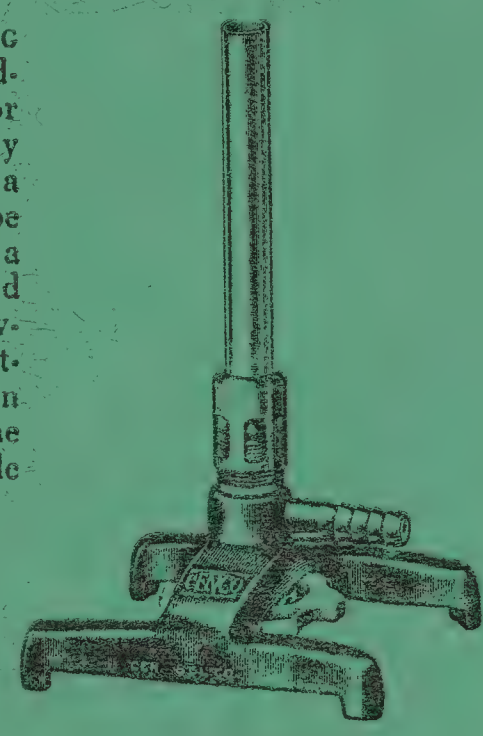

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-:- NORTHWEST SCIENCE -:-

Published quarterly by the Northwest Scientific Association

Entered as Second Class Matter, April 5, 1927, at the Post Office at Cheney, Washington. Office of Publication, Cheney, Washington. Subscription Price to Members, Including Dues, One Dollar per Year; to Non-Members, One Dollar.

Volumes I to XVI, 1927 to 1942, each $1.25
All Sixteen Volumes, $16.00

See Important Announcement, Page 98.

VOL. XVII, NO. 4. **NOVEMBBER, 1943**

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LOCAL APPLICATION OF STANDARD METEOROLOGICAL REFERENCES

BY PAUL W. STICKEL

Silviculturist, Division of Forest Management, Northern Rocky Mountain Forest and Range Experiment Station

When in need of climatological information concerning a particular place or small area, scientists as well as laymen commonly consult "standard meteorological references." There are several so-called standard texts used for this purpose and in teaching meteorology. These give students opinions of climatic conditions which they may retain throughout their lives, and it is therefore essential that the degree of applicability of these standards be recognized. "Standard" according to Webster's New International Dictionary is "an accepted or established rule or model." This same authority, furthermore, states that when used synonymously with criterion, standard has the additional implication of a test. The present article is therefore a test of a test in that it examines the applicability of certain standard meteorological references for one spot in northern Idaho.

[1] The subject of this article was first suggested by H. T. Gisborne, in charge of the Division of Forest Management, Northern Rocky Mountain Forest and Range Experiment Station, who likewise contributed to its development and to whom grateful acknowledgment is made for his assistance.

One of the most commonly used meteorological references, for generalized information, is the "Atlas of American Agriculture" (**3**) with its separate "Parts" I, II, III, etc., pertaining to temperature, frost and the growing season, precipitation and humidity, etc. The Atlas was published almost a decade ago; its maps, charts, and tabulations are based upon the 20-year period 1895 through 1914. Intended also to serve the same need for a general meteorological reference book and directed particularly to the farmer's business is "Climate and Man" (**1**), the 1941 Yearbook of the U. S. Department of Agriculture. Its maps and tabular statistics are supported by forty years of meteorological records (1899-1938). In addition to showing the weather conditions for the United States as a whole, the 1941 Yearbook contains supplementary material by individual states which depict the average temperatures, precipitations, and frost-free periods.

Data from these references are frequently used as "source material" and cited as of unquestioned authority by general meteorological textbooks; they are also freely drawn upon in prepar-

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ing specialized publications (**2, 7, and 11**) and articles appearing in technical magazines such as "The Scientific Monthly" (**9 and 10**). The detailed weather records by days and months published currently by the U. S. Weather Bureau as "Climatological Data" for each state are only rarely used for quick reference. Their data are too voluminous and they furthermore are intended primarily to reveal the current weather rather than the typical and most significant features of a climate. Also published by the U. S. Weather Bureau and revised from time to time is the so-called Bulletin W—"Climatic Summary of the United States." This supplements the "Climatological Data" reports in that it contains more deailed information on temperature, rainfall and snowfall, number of days with precipitation, and prevailing wind direction for each month and for the year.

The accuracy and applicability of the more generalized standard reference material are affected by several factors: First is the scale of the maps used. It is impossible, of course, to portray all local variations because of the small scale commonly used. Second, as pointed out by Visher (8) more than 20 years ago, local climates are highly complex, being influenced by many factors chief among which are the geographic and physiographic features of the locality. Third is the geographic and altitudinal distribution of the weather stations used as a basis. The Inland Empire has more area lacking representative stations than it has area which can be typified by existent meteorological data.

Failure to find the desired information in these standard references also seems to depend considerably upon what may be termed "customary" past practices of measurement and publication. For example, no data may be found for annual mean maximum and minimum temperatures, spring, fall, and warm-season temperatures, humidity, or intensity of rainfall because these elements are either not customarily measured at many meteorological stations, or if measured they are not compiled and published. Similarly, even though daily depth of snow on the ground is recorded at all cooperative stations maintained by the U. S. Weather Bureau, these highly useful data are seldom summarized on a semi-monthly or monthly basis on so-called standard maps. Again, wind-velocity data may be missing, or the 24-hour average velocity may be found, whereas the daytime or afternoon velocity is the feature of chief interest. And despite the urgent recommendation for standardization made by a Presidential Committee a decade ago (7), the 24-hour average wind velocity may still be a measurement taken at 42 feet above the ground at one station (Spokane airport) or at 454 feet at another (New York City), according to the usual past practices. Finally, and of real practical consequence, is the fact that in many instances—especially for precipitation data—the so-called "normal" climatological values given are mere mathematical averages and do not represent the fifty-fifty probability commonly and technically attributed to the term "normal" (**5**).[2] This incongruity led the Hydrological Section of the American Geophysical Union in 1941 (4) to recommend that in the future, at least for hydrological studies, normals of precipitation be defined by the median.[3]

To remedy some of these omissions and incongruities, the Northern Rocky Mountain Forest and Range Experiment Station has recently completed a 30-year summary (1912 through 1941) of the weather records taken at its Priest River Experimental Forest in northern Idaho. This detailed analysis. to be published soon, offers one opportunity for comparing the salient features of the local climate of the area as indicated by so-called standard references and as revealed by the accurate and detailed measurements made for

[2] The U. S. Weather Bureau expects in the next revision of its Bulletin W to include the publication of both the mean and median values for all climatological records listed therein.

[3] The median is the only statistical average that is always based upon the middle item of a series when all the items are arranged in order of magnitude.

30 years at one typical valley-bottom station in mountainous, forested northern Idaho. For convenience, the climatological elements have been grouped into three subdivisions: temperature, precipitation, and miscellaneous. In each of the tables that follow, the 30-year Priest River averages, either the mean or median, are listed first. These are followed by similar data selected from the various standard texts.

1. Temperature Phenomena

A study of Table 1 shows, as far as temperatures are concerned, that the standard references—generalized though they may be—portray the air temperature aspects of the Priest River climate with a high degree of accuracy except for the frost-free period and the average annual absolute minimum expectable. All of the usually consulted references indicate that the local climate has a frost-free period that exceeds actual conditions by from 10 to 45 per cent. This is an error having serious implications from an agricultural crop-production standpoint. Climatically, the Priest River area is locally known to be precarious to crop raising, and the Priest River Experimental Forest data substantiate this. Actually, from June 1 through August 31 there have been freezing temperatures in 24 out of the 30 years of record at this station.

The standard references examined all correctly portray the average annual absolute maximum temperature of about 98° for this spot. In the case of

TABLE 1. Air temperature (°F.).

	Priest River data	Climate and Man	Idaho Section of Climate and Man	Economic Atlas of the Pacific Northwest	Atlas of American Agriculture	Atlas of the Historical Geography of the U. S.	Visher's Temperature Contrasts in the U. S.
Annual mean ...	43.7	40 to 45					
Annual mean maxmum	56.5	No. data in ANY of these references.					
Annual mean minimum	30.9	No data in ANY of these references.					
Average annual absolute maximum	98.0	95 to 100			95 to 100	90 to 100	95 to 100
Average annual absolute minimum	-21.5[1]	-10 to -20			-10 to -15	-10	-10 to -20
Highest ever observed	102	100 to 105					100 to 105
Lowest ever observed	-35	-30 to -40			-30 to -40		-30 to -40
January mean ...	23.7	20 to 30	24		20 to 25	25	20 to 30
January maximum	30.5				30 to 40		
January minimum	16.9				10 to 20		
July mean	64.3	65 to 70	over 66		over 65	65	65 to 70
July maximum	83.6				over 80		
July minimum	45.0				50		
Spring season mean	43.4	No data in ANY of these references.					
Summer season mean	61.7				60		
Fall season mean	43.7	No data in ANY of these references.					
Winter season mean	25.7				25		
Warm season mean (April through Sept.).	55.7	No data in ANY of these references.					
Date of last killing frost in spring	June 5[1]	May 30	May 30	June 1			
Date of first killing frost in fall	Aug. 26[1]	Sept. 20-30	Sept. 30	Sept. 1			
Average length of frost-free period (days)	82[1]	over 120	100	90 to 120	90	90 to 120	80 to 120

[1] Median values; all others mean values.

average annual absolute minimum temperature, however, none of the standard reference values quite approach the figure of -21.5° and one of them (**7**) even gives a temperature that is almost 12° above the true absolute minimum to be expected during the average year.

2. Precipitation Phenomena

While temperature extremes often control both crop and timber types, precipitation is perhaps the climatic element of most vital general interest. It is certainly of immediate concern to anyone dealing with crop production, when during a 30-year period there have been five growing seasons each in which only 0.05 inch of rain fell—July 1917, 1919, 1929, and 1934 ,and August 1931. Furthermore, the Priest River records show that at least once in each of the last three 10-year periods there has been a July-August (62-day) drought of less than one-half inch precipitation. The significance of such droughts to forest-fire control and to crop growing is obvious. In contrast, the all-time maximum precipitation intensity record was established by a storm that occurred during these normally dry months, for on July 14, 1937, 0.33 inch of rain fell in five minutes. This is at the rate of 3.96 inches per hour and was definitely erosive to steep cultivated fields. Contrary to popular conception, excessively heavy midsummer rains have been noted to be the cause of far greater erosion damages than heavy rains during the wettest months.

A comparison of the data in Table 2 discloses the fact that the standard references do not present the precipitation phase of he Priest River climate with nearly the same degree of accuracy as they do the air temperature element. For example, the most recently published standard text overestimates the annual average precipitation of this portion of northern Idaho by about 6 per cent on its generalized map of the entire country (**1, p. 711**). Strangely enough, this same authority on its more detailed Idaho map (**1, p. 839**) underestimates the annual average precipitation by almost twice that percentage, 11.5 per cent. Only in the case of the average spring-season precipitation do the standard texts present seasonal precipitations with a reasonable degree of accuracy. Particularly striking and of practical significance are the misrepresentations of the true summer-season rainfall of 2.95 inches. The standard references all overestimate this by 1.05 inches or almost 40 per cent. To a lesser degree this is also true with regard to the warm-season rainfall figure—the period of chief concern to crop producers—that is overestimated by from 12 to 25 per cent. The remaining seasonal precipitation values cited by the references are in general erroneous by being too small.

An engineer constructing culverts to take care of maximum flash flood flows or a soil conservationist designing upstream structures to impound the runoff of excessively heavy storms in order to prevent down-stream erosion in the Priest River area would be apt to find his improvements inadequate if they were made to take care of the precipitation-intensity rates given in standard references. As shown in Table 2, these almost invariably give smaller rainfall-intensity values than have actually been measured during the past 30 years at this spot in northern Idaho. The 5-minute intensity rate cited by Yarnell (**11**) for this portion of North Idaho is fairly close, being 9 per cent less than the record 5-minute downpour of 0.33 inch experienced in 1937. For intervals increasing up to 2 hours, Yarnell's errors increase, until for a 2-hour period his data indicate only 60 per cent of that actually recorded. For a 24-hour period, Yarnell's data show 22 per cent more than the actual maximum. All standard references likewise underestimate the average annual snowfall, as well as the average annual number of days with a snowcover of 1 or more inches.

The marked variations disclosed by this analysis of these precipitation data are a reflection of two conditions. In

TABLE 2. Precipitation (inches).

	Priest River data	Climate and Man	Idaho Section of Climate and Man	Economic Atlas of the Pacific Northwest	Atlas of American Agriculture	Atlas of the Historical Geography of the U. S.	Visher's Average Precipitation Contrasts in the U. S.	Yarnell's Rainfall Intensity-Frequency Data
Annual average	28.29[1]	30	25	More than 30	More than 30	28 to 40	20 to 30	
Spring season average	5.60[1]	4 to 6			6		Less than 4	
Summer season average	2.95[1]	4			4		Less than 4	
Fall season average	7.59[1]	4 to 6			10		6	
Winter season average	11.02[1]	10			8		More than 8	
Warm season average (April through September)	8.01[1]	10	8 to 10	9[2]	9		Less than 10	
Maximum in 5 minutes	0.33							0.30
Maximum in 10 minutes	0.58							0.50
Maximum in 15 minutes	0.86							0.62
Maximum in 30 minutes	1.16							0.75
Maximum in 1 hour	1.18	Less than 1			Less than 1			0.80
Maximum in 2 hours	1.26							0.75
Maximum in 24 hours	2.05	2			Less than 2			2.50
Maximum in 1 month	11.22	10						
Average annual number days with 0.01 inches or more	135[1]	100 to 140						
Average annual snowfall	79.0[1]	60 to 100			More than 60		50 to 75	
Average annual number days with 1 inch or more snowcover	106[1]	60 to 80			More than 90	90		

[1] Median values; all others mean values.
[2] April through August.

the first place, they are no doubt attributable in part to the fact that most of the Priest River precipitaion averages used here are based upon median figures—the truly normal value—whereas similar data appearing in standard texts are derived from mean figures that are seldom truly normal. Second, many of the basic compilations from which standard reference data are derived—particularly measurements made by automatic recording instruments such as sunshine, relative humidity, and precipitation intensity—are based upon interpolations of the records of so-called first-order U. S. Weather Bureau stations (**1, p. 689**). These are for the most part located in cities that in turn are situated usually in the larger valley botoms, the local climates of which are significantly different from adjacent mountain valley bottoms. For example, in the case of the Priest River area, the nearest first-order U. S. Weather Bureau station is located at Spokane, some 55 miles to the southwest. Furthermore, the elevation above sea level of the Spokane station is 1955 feet whereas that of the Priest River station is 2380 feet. While this difference in elevation is not great, the effect of the mountain topography surrounding the Priest River station is evident in the fact that both the mean annual precipiation and snowfall at Spokane are only half that measured at Priest River.

This weakness of standard reference data can be corrected only by supplementing already established first-order stations with an expanded network of hydro-meteorological stations that reach back into the higher-lying headwaters of important forested mountainous watersheds. In 1939 the Hydro-Meteorological Research Section of the Rivers and Flood Division, U. S. Weather Bureau in cooperation with the Corps of Engineers, U. S. Army and the U. S. Department of Agriculture formulated plans for such an extensive network of precipitation stations. The present test of standard references shows clearly that every effort should be made to put that plan ino practice as early as possible. Already more accurate and correct snow data of the inaccessible but highly important back country are being made available through the summaries of snow surveys published by the Division of Irrigation, Soil Conservation Service in cooperation with other governmental, state, and public utilities agencies. In many places these data are already revealing more annual precipitation in the form of snow alone than is generally reported for both rain and snow.

3. Miscellaneous Phenomena

The record of occurrence of thunderstorms is of practical use to all local forest-fire control organizations. As Table 3 shows, the area around Priest River has on the average 17 thunderstorm days annually. This agrees substantially with the figure of 10 to 20 thunderstorm days cited for the area in the more recently published standard references.

In climatological work, character of day is most commonly expressed in terms of number of clear, partly cloudy, and cloudy days. It is a meteorological

TABLE 3. Miscellaneous phenomena.

	Priest Rvier data	Climate and Man	Atlas of American Agriculture	Visher s Average Precipitation Contrasts in the U. S.
Mean annual number thunderstorm days....	17	10 to 20	Less than 20	
Mean annual number clear days.....	128	Less than 100	100	10 to 20
Mean annual number cloudy days.....	150	More than 140	140 to 160	

observation of long standing. With the rapid developments in aviation, character-of-day data have assumed a decidedly new practical use because they give an indication of atmospheric visibility. Table 3 shows that the standard references correctly state the mean annual number of cloudy days common to this section of North Idaho, but that they underestimate the number of clear days by almost 25 per cent.

Summary

This test of local applicability of standard meteorological references has pointed out certain misrepresentations and has shown the desirability of searching for and using other and perhaps newer sources of information. It leads to the conclusion that serious errors of practical significance to crop production may result when the frost-free period and the incidence of precipitation of a small area are determined from standard meteorological maps. Until the expanded network of hydro-meteorological stations already referred to can be effectuated, rainfall intensity data in standard texts should be viewed critically as far as small areas are concerned. Land-use planners and preparations for post-war extensions of agriculture should not rely entirely on the so-called standard references without full appreciation of meteorological differenecs between mountain valleys and the more open, plateau or broad valley-bottom locations of the older meteorological stations. Furthermore, when data are required for local application, the basic records from the nearest adjacent stations should be used whenever they are available instead of the more generalized maps.

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A HISTORY OF RANGE USE AND ITS RELATION TO SOIL AND WATER LOSSES ON THE WALLA WALLA RIVER WATERSHED, WASHINGTON AND OREGON

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INTRODUCTION

The present condition of any watershed reflects the land-use practices that have been employed on that watershed throughout its history. Except in instances of severe early misuse, recent practices will leave a greater impress than earlier ones. Recommendations of the most desirable type of land use, whether primarily to improve the economic condition of the residents on the watershed or in the community, or to reduce excessive soil and water losses in order to prevent local or downstream flood or siltation damage, or for whatever purpose, will be more adequate if based on a thorough knowledge of the causes back of the deteriorated condition.

The Walla Walla River and its tributaries rise on the northwesterly facing slopes of the Blue Mountains in southeastern Washington and northeastern Oregon, and flow in a westerly direction across a rolling plain to enter the Columbia River near Wallula, Washington, 312 miles upstream from its mouth. The watershed covers most of Walla Walla and Columbia Counties in Washington, and part of Umatilla and Wallowa Counties in Oregon. It is about 60 miles long from east to west and 50 miles wide from north to south, and contains approximately 1,795 square miles.

Vegetation Prior To White Settlement

Until as late as 1860 the soils were well stabilized by the native vegetation; timber and brush intermixed with grass and weeds on the Blue Mountains, bunch and associated grasses (**Agropyron spicatum, Poa secunda,** and **Festuca idahoensis** for the most part) on the rolling hills of the middle and lower watershed, and wild rye (**Elymus condensatus**) and sagebrush (**Artemisia tridentata**) in the valleys. Prior to establishment of the Whitman Mission in 1803, the grass-covered hills were assumed to have limited agricultural possibilities, grazing being the only use for which they were believed adapted. The comparatively restricted valley areas, even, were rated far below their true productivity.

Original Grazing by Game Animals

So far as known, none of the Walla Walla River watershed area was grazed heavily prior to about 1860. Game animals—antelope, deer, and elk—roamed over the area, but because of predators, probably rarely became sufficiently numerous to overgraze the range. Buffalo, although ranging east from western Montana to the Atlantic Ocean, (2, 15)[1] seem to have occurred only occasionally on the area drained by the Walla Walla River or its tributaries.

Introduction of Horses

Horses were apparently first introduced into the region about 1730 (8). Santa Fe, New Mexico, seems to have been the center of distribution for these, as well as for most, or all, of the horses of the western plains. In spite of the grazing by these Indian horses, there is no indication that the range suffered from overgrazing until the introduction of large numbers of cattle, sheep and draft horses over a hundred years later.

Expansion of the Livestock Industry

A treaty with the Indians in 1859 assured would-be settlers of comparative safety, and initiated an era of rapid expansion and settlement. The stock-raising possibilities of the grass-covered hills were beginning to be recognized

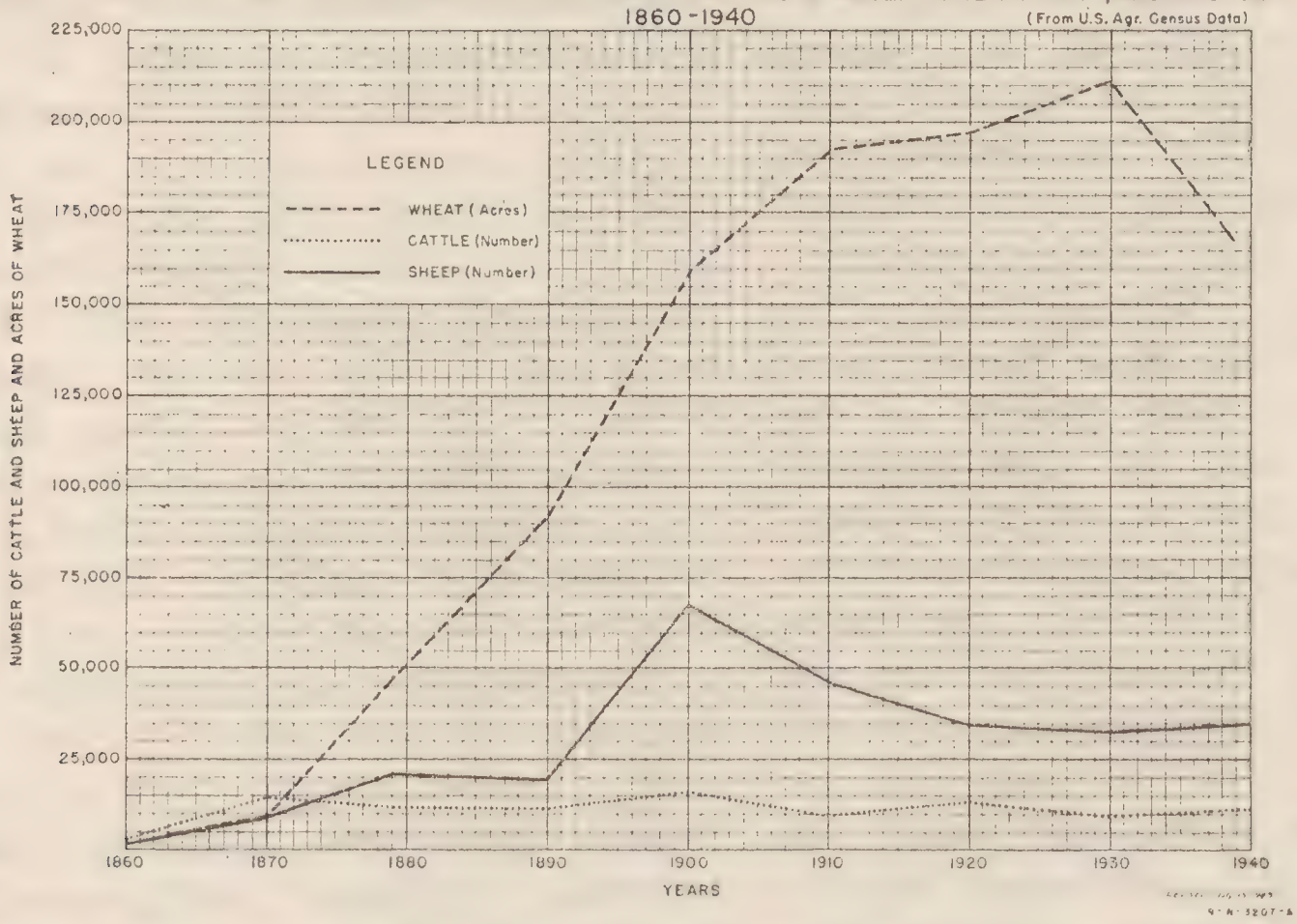
[1] Numbers in parenthesis refer to bibliography at close of this article.

and by the end of 1859 scattered ranches were established in the northern foothills of the Blue Mountains and up the Touchet River as far as the present site of Dayton. The discovery of gold and other minerals in Idaho, eastern Oregon, and elsewhere further stimulated settlement and provided a market for disposal of livestock and other agricultural products. Up to this time there were few sheep or beef cattle in the area, most of the cattle being milch cows or oxen, and the sheep consisting of small farm flocks for local or domestic use.

In the summer and fall of 1861, however, large numbers of both sheep and cattle were driven into eastern Oregon and Washington from the Willamette Valley. The winter of 1861 was one of the most severe ever recorded in the Pacific Northwest, and almost wiped out these rather speculative attempts at livesock raising. Out of 4,500 sheep driven into the Yakima country that fall only 45 were alive by spring. Cattle and horses, likewise, were very hard hit, and the total monetary value of stock lost in the country around Walla Walla was esimated at about $10,000,000 (6, 12). In spite of this severe setback, however, the movement of stock, both cattle and sheep, into eastern Oregon and Washington continued. In 1864 about 6,000 sheep were driven into the Walla Walla area, and it is recorded that by the winter of 1865-66 200,000 sheep were being wintered there. At this time, however, cattle were in greater local demand than sheep, and the number of cattle raised in the county first approximated the peak they ultimately reached in 1900 (fig. 1). Extensive shipments to eastern markets began about 1875. Prices were low, however, and continued so until the severe winter of 1880-81 which killed off about 50 per cent of the cattle in eastern Washington and Oregon (17). Since that time the number of cattle in the county, though subject to minor fluctuations, has tended to remain more or less constant.

The numbers of sheep, which essentially paralleled those of cattle until 1890, increased much more rapidly until 1900 (fig. 1). Whereas in 1890 there were less than twice as many sheep than cattle, in 1900 there were more than four times as many. A superiority in sheep numbers, though a little less than this, has continued down to the time of the latest available records in 1940.

FIGURE 1 GROWTH OF THE LIVESTOCK INDUSTRY AND WHEAT RAISING IN WALLA WALLA COUNTY, WASHINGTON
1860-1940 (From U.S. Agr. Census Data)



Development of Dry-Land Wheat Raising

Up to 1863 small grains, wheat, oats, and barley were raised only in the

flood plains bordering the stream courses. In the fall of 1863, a farmer by the name of Andrew Kilgore sowed 50 acres of wheat on the upland near Weston and the following summer threshed an average of 35 bushels to the acre from his small plot (4). The news—and the practice—spread rapidly, until in 1867 the wheat raised near the Blue Mountains exceeded the demand, and by the early seventies Walla Walla, Wasco, and Umatilla Counties were coming to be known as "one of the world's great granaries." There was a consistent increase in the acreage of land devoted to wheat raising which reached its peak in 1930. The records for 1935 showed a moderate decrease.

Effect of Wheat Raising on Horse Numbers

With the development of wheat raising the need for draft horses increased, and the number of horses in Walla Walla County increased from 1,070 in 1860 to 13,625 in 1900 (20, 22). There were still essentially this many in 1920, but fifteen years later the development of power farming had cut this figure almost in half, 6,937 animals being recorded for 1935. During the rather long periods when these horses were not in use they were grazed on the stubble fields and on the adjacent range lands. In 1904, 15,000 horses were grazing the area proposed for the Wenaha National Forest, and were concentrated for the most part on the foothills area below the timber (10). Heavy use similar to this continued for many years and must have played an important part in contributing to deterioration of the range. Present Forest Service policy now permits no horses on open range on the Umatilla National Forest.

Overgrazing and Its Effect On the Plant Cover

On a basis of present range use by cattle and sheep, the degree to which these animals utilize available feed, and the condition of the range, it seems probable that the grazing lands of the watershed have been subjected to some degree of overgrazing since about 1875, a period of 65 years. Moreover, grazing use has tended to become heavier, rather than lighter, during this time. This is indicated by the fact that development of wheat raising has consistently removed more and more of the native grasslands from grazing use, while the numbers of cattle have remained essentially constant and those of sheep have increased.

This consistent overuse of the native forage is evident everywhere on the watershed except in inaccessible areas and areas so far removed from water that they receive little grazing. In many places the original grasses have disappeared and have been replaced by annual grasses, downy chess **(Bromus tectorum)** for the most part.

All degrees of deterioration from the original vegetative cover occur. Locally, largely on ridge-tops of the upper watershed, either no vegetation (and in many cases no topsoil) now remains, or a scattered stand of weeds and local remnants of grass form an ineffective "cover" that has little or no control over accelerated soil loss and water loss. The origin of these more or less unvegetated ridges has given rise to much speculation, opinion being divided as to whether they antedate heavy grazing on the forest areas, or have resulted from heavy local grazing and excessive trampling. The tentative conclusion reached in this study is that with a few exceptions these ridges were probably at one time covered either with a rather heavy stand of grasses (mostly **Agropyron spicatum** and **Poa secunda)** intermixed with some weeds, or with a more open stand of bunch grass with a larger percentage of weeds. These conclusions are based on the following evidence: (1) early descriptions of the area; (2) scattered remnants of a good grass cover on local areas; (3) relict areas that still support excellent stands of **Agropyron spicatum** and **Poa secunda.**

National Forest Areas

By 1900 it was rather generally recognized that much of the forested range

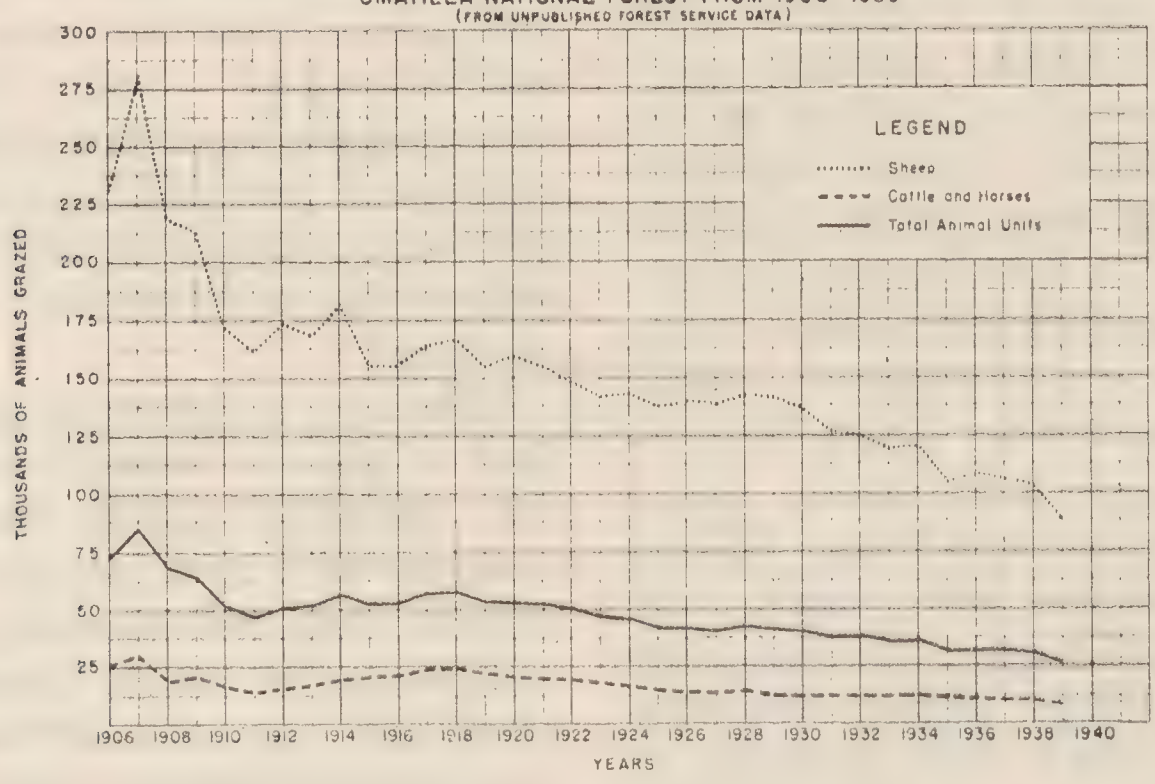
was in poor condition as a result of overgrazing and improper seasonal use. There is little likelihood, however, that any immediate action would have been taken to remedy the situation had it not been for the creation of the forest reserves. In 1905 the Wenaha Forest Reserve was set aside by presidential proclamation (13). This original reserve included that portion of the present Umatilla National Forest now included within the Walla Walla watershed. Prior to 1905 the forest lands were clcassed as public range, and were subject to all the abuses of early and heavy grazing that might be expected in a region where summer range was at a premium.

The first administrative act of the Forest Service was to subdivide the forest into allotments based on prior use. Reductions in the numbers of sheep and cattle permitted have been practically continuous since the first world war (fig. 2). Drought and increasing use by big game, however, have prevented these reductions in use being fully effective in range restoration. A vegetal survey was made in 1913 to provide information on the vegetal types of the national forest area (24). Yearly range condition and utilization estimates have been depended upon to determine the grazing capacity of the federally-owned lands of the watershed.

About 200,000 sheep, 40,000 cattle, and 15,000 horses were grazing the reserve area in 1904 (10). Both cattle and horses were confined largely to the foothill slopes of the mountains, seldom grazing the higher timbered country. Sheep, on the other hand, spent the summer months in the timber, grazing the foothills en route to and from the summer range.

Figure 2, which shows the number of cattle and horses, and of sheep grazed on the area now included within the Umatilla National Forest, indicates the reduction that the attempt to reach the correct carrying capacity has necessiated. The increase in the numbers grazed from 1912 to 1918 reflects the pressure for beef and other livestock products during the first World War, rather than any increase in the range carrying capacity during this period. An almost record drought in 1911 followed in 1912 by one of the wettest years in the history of the watershed may have given added initial impetus to this increase.

FIGURE 2 NUMBERS OF SHEEP, AND OF CATTLE, AND TOTAL ANIMAL UNITS GRAZED ON THE UMATILLA NATIONAL FOREST FROM 1906 - 1939
(FROM UNPUBLISHED FOREST SERVICE DATA)



Closure of Mill Creek Watershed To Grazing

Following agitation for a number of years by residents of Walla Walla, the Mill Creek drainage basin (source of the Walla Walla municipal water supply) was closed to all grazing in 1925. This had been preceded for a number of years by grazing restrictions, particularly affecting sheep, that had lightened the grazing load on this por-

tion of the watershed more rapidly than on the remainder of the national forest. During the 15 years that have elapsed since 1925 the Mill Creek area has had no grazing by domestic stock. Predators have been rather consistently trapped or hunted, while deer and elk have increased unchecked. As a result the more or less natural balance has been upset, and the grazing pressure by game animals has increased until much of the watershed is now overgrazed, the soil disturbed by trampling, and erosion—which temporarily had become largely stabilized—is again active. Pollution of the Walla Walla city water supply similar to that occurring in the summer of 1940 can be expected to recur with increasing frequency in the immediate future if steps are not taken to reduce the natural yearly increase of game animals.

Effect of Fires

Fires have played their part in determining the type of vegetation able to thrive on the higher timbered portion of the waershed as well as on the grassed areas below. Fires occurred rather frequently even prior to white settlement, and as they burned almost or entirely unchecked, they were often large and extremely destructive. Run-off, from burned timber lands in particular, must have been heavy for a few years following these fires. On the grassed areas, on the other hand, most of the grass species were fire-enduring and recovered rapidly, so that excessive soil and water losses soon returned to normal. In addition, the grass fires were of short duration and did not burn the organic matter out of the soil as completely as did the timber fires.

Early Floods and Flood Damage

Native vegetation alone can rarely prevent floods; it can, however, exert a degree of control over flood run-off that tends to reduce the peaks of flash floods, retards their rate of rise and fall, and reduces the amount of sediment and debris they would otherwise carry. Data on early floods in the Walla Walla watershed, though somewhat meager, indicate that floods occurred not infrequently. Gilbert (6) reports that on June 14, 1869, "A storm occurred of tropical fierceness, during which a waterspout burst in the mountains, and sent a flood down Cottonwood Canyon that washed away houses in the valley."

Quoting Gilbert further: "The last three days of January, 1867, witnessed a flood in Walla Walla that damaged property to the extent of $18,000. A warm rain brought down torrents of water from the melting snow on the mountains, and Mill Creek soon overflowing its banks, rushed down Alder Street, converting the lower end of town into a lake. Many buildings along the creek line were washed away, and others were seriously undermined and damaged. The floods occurred nearly every year, but seldom did much damage or reached uncontrollable proportions. One, however, in 1875 caused the destruction of considerable property."

Although the $18.000 damage attributed to the 1867 flood is much less than that incurred during 1931-33 (18), it must be kept in mind that Walla Walla in 1867 was little more than a country crossroads, as Indian depredations had prevented general settlement of the surrounding territory until 1858.

It is of interest to note that although flood records on he watershed date back to 1867, none of the early accounts mention sediment damage. This does not constitute proof that such damages never occurred, but it does strongly indicate that if there were such damages they were relatively insignificant.

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INTERPRETING MOUNTAIN MEADOW RANGE CONDITION BY OBSERVING TREND AND STAGE OF PLANT SUCCESSION

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Importance of Meadow Forage

Mountain meadows in Washington and Oregon potentially are capable of producing 10 to 15 times more forage per acre than the average timbered summer range that is predominant in these States. The forage that is produced on meadows ordinarily stays lush and green throughout the summer grazing period in contrast to the timbered summer range forage which usually begins to dry in August. Range forage in a cured state usually is low in protein, in calcium and phosphorus, and in vitamins, and is incapable of producing rapid weight gains in livestock. Although mountain meadow acreage is but one or two per cent of the total summer range in Washington and Oregon, it is capable of producing an important amount of summer forage that is critically needed to produce prime beef and lamb.

Mountain meadow forage is so attractive to grazing animals that, if preventive measures are not taken, the meadows usually support more than their share of the grazing load. As a consequence, range depletion has occurred that in many instances has reduced meadow grazing capacities to or below the level of the timbered range. This forage production loss sometimes goes unnoticed because of the small areas that are involved. In other cases, the importance of the feed loss is apparent and steps are taken to correct the grazing management so that the production of meadow forage may be increased. The situation with respect

to mountain meadow range is a generally lowered production with some meadows improving and others losing in productiveness. Those responsible for the management of summer range in Washington and Oregon should uniformly recognize the importance of meadow forage and should be able to judge the condition and trend of the vegetation in order that proper and timely adjustments in handling the meadows may be made.

On the hypothesis that knowledge of plant succession and retrogression affords a practical means of judging meadow condition, the Pacific Northwest Forest and Range Experiment Station has studied the vegetation of 31 meadows in eastern Oregon. Based on careful range inspections that took such factors as soil erosion, plant vigor and plant density into consideration, these meadows were classified with respect to range condition in four groups: excellent, good, fair, and poor. The average density and composition of range plant species was obtained for meadows in each grouping in order to establish significant indicators of meadow condition and of trends from one condition to another.

The term, plant succession, is not used in the discussion that follows to describe the hydroseres of meadow development, but rather to delineate vegetation stages from or toward the mesophytic community of grasses and sedges that dominate on meadows in good range condition. For practical purposes this community is termed the climax stage, and the vegetation on badly depleted meadows the first weed stage. The succession that will be discussed takes place under mesophytic or xeric conditions and is entirely man-caused.

Earmarks of Meadow Condition

The vegetation of the four meadows that were classified as excellent was found to cover 70 per cent of the ground surface and to consist largely of perennial grasses, chief of which was tufted hairgrass. Tufted hairgrass[1] made up nearly ¾ of the total vegetation. Grasslike plants, most important of which was Nebraska sedge, represented about 15 per cent of the vegetation. Perennial weeds made up about 10 per cent; annual grasses and weeds, thinly scattered in the stand, accounted for the remainder of the plant cover. The chief characteristics determined of meadows in excellent condition were, therefore, a vegetation of high density consisting mainly of tufted hairgrass, a noticeable quantity of Nebraska sedge, few weeds of any kind, and virtually no annuals.

On the eight meadows in good condition, vegetation covered half of the ground surface. The composition was about equally divided between perennial grasses and showy perennial weeds. Grasslike species made up about 15 per cent of the vegetation. Tufted hairgrass still was the dominant grass, but thin bentgrass was a close second on meadows in good condition. Ovalhead sedge was about as noticeable as Nebraska sedge in the grasslike group and both tended to be surpassed by Baltic rush. Of the perennial weeds, western aster and Columbia groundsel were usually most abundant although American bistort and other showy weeds sometimes dominated the landscape.

The vegetation on the 13 meadows in fair condition covered about ⅓ of the ground surface and was comprised largely of perennial weeds which made up ⅔ of the vegetation. Only ¼ of the vegetation was perennial grasses. Grasslike species were not prominent and the density of annual weeds and grasses was found to be low. Tufted hairgrass on meadows in fair condition was less than ¼ of the grass cover, being surpassed by Kentucky bluegrass and equalled by red fescue and thin bentgrass. Nebraska sedge usually was absent, being replaced largely by ovalhead sedge. Columbia groundsel, western yarrow, cinquefoil, western aster, and common dandelion were the most

[1] Common and scientific names of range plant species referred to are listed at the end of this article.

abundant perennial weeds.

The six poor condition meadows supported a vegetation that covered only 10 per cent of the ground surface. Annual weeds, principally Douglas knotweed and tarweed, made up 40 to 50 per cent of the cover. Annual and perennial weeds together made up about ¾ of the entire vegetation. Annual grasses were two or three times more abundant than perennial grasses. Tufted hairgrass had largely disappeared from the meadows in poor condition, the most abundant perennial grass being slender hairgrass which is practically worthless for forage or for arresting soil erosion. The most abundant perennial weeds were common dandelion, cinquefoil, and western yarrow.

Grazing capacity estimates based on surveys of the individual meadows, with forage values established by careful sheep grazing trials, show that the meadows in excellent condition can support 10.5 sheep months of use per acre on the average. Similar values determined for meadows in good, fair, and poor condition were 6, 3.9, and 0.7 sheep months per acre respectively. Thus, lowering the range condition by one class results in a loss of about 30 per cent of the grazing capacity. Tufted hairgrass forage produced four-fifths of the grazing capacity on meadows in excellent condition.

Summarizing the vegetation characteristics of the meadows in different condition classes, it is apparent that the four groups fall into rather definite plant succession stages. The best condition answers the definition of the climax stage being dominated with a single species, tufted hairgrass. The good condition, with about equal division between perennial grasses and weeds, is typical of the mixed grass-and-weed stage. The fair condition in which perennial weeds are about three times as abundant as perennial grasses is corollary to the second weed stage. The poor condition, wherein annual weeds constitute more than one-half the vegetation and weeds as a class make up ¾ of the plant cover, is illustrative of the first weed stage. The rapid decrease in grazing values signifies the validity of the range condition classification. The guides to determine relative meadow condition can therefore be based on the plant succession stage, most outstanding earmarks of which are the density of vegetation, the proportion of weeds to grasses, the abundance of tufted hairgrass, and the presence or absence of annual weeds.

Identification of Trend in Meadow Condition

The trend in condition of meadow range is associated with the dynamic phases of plant succession and retrogression. Accordingly if one is familiar with the characteristics of plant succession stages on meadows, it is but a step further to determine approximately the trend or direction of the succession. On the meadow examined that were in the lower stages and which definitely were improving or deteriorating in range condition, observations were made that can serve to guide such a determination. The most significant of these observations are as follows:

(1) When dealing with meadows that are in near-climax condition, the places to watch for deterioration are the drier, better drained spots. Here the tufted hairgrass will be thinning and low in vigor if the meadow condition is retrogressing, and species such as thin bentgrass, Kentucky bluegrass, red fescue, western aster, ovalhead sedge and other secondary species will be in a thrifty condition and spreading. On the other hand if the meadow vegetation is improving, the tufted hairgrass on these sites although thin in stand will be comprised of young, vigorous plants that obviously are making a go of it in competition with the species already mentioned.

(2) If the meadow is in the mixed grass-and-weed stage, a sign of deterioration is the absence or sparseness of tufted hairgrass on the drier sites and a thinning of this species on the more moist situations. Mountain brome, slender wheatgrass, ovalhead sedge,

and weeds such as Columbia groundsel, western yarrow, western aster, and cinquefoil will be common and abundant on the dry sites. Kentucky bluegrass, red fescue, and thin bentgrass will also be spreading on the relatively moist areas. There is a tendency for meadows deteriorating from the mixed grass-and-weed stage to take on a decidedly patchy appearance due to the colonization of dry patches by weeds which flower brilliantly. A sign of betterment in meadows that are in the mixed grass-and-weed stage is a thick, healthy stand of tufted hairgrass in the moist locations, with a scattering stand of young hairgrass plants on the moderately dry sites. Another good sign is the thickening of Kentucky bluegrass, thin bentgrass, and red fescue in patches of perennial weeds on dry situations.

(3) Signs of deterioration from the second weed stage are the occurrence of thrifty tufted hairgrass only in very wet places, the bulk of the meadow covered with weeds such as western yarrow growing in a clumped, turflike form and common dandelion growing with a prostrate rosette habit. Another sign of deterioration is oniongrass growing in a semidecumbent form on the drier sites. The absence of perennialy grass seedlings and the presence in great abundance of annual weeds even on moist spots are indicators of retrogression. Signs of improvement are young, thrifty tufted hairgrass plants spreading on the drier sites, and invading areas dominated by red fescue, Kentucky bluegrass, and thin bentgrass. Another sign of improvement is the invasion of perennial weed colonies by Kentucky bluegrass, thin bentgrass, and red fescue.

(4) Signs of meadow improvement from the first weed stage are young tufted hairgrass plants becoming established in wet places; Kentucky bluegrass, red fescue, and thin bentgrass spreading noticeably in patches of annual and perennial weeds on moist ground; and young littleflower penstemon, Columbia groundsel, cinquefoil, western yarrow, and other perennial weeds becoming established on the driest sites in competition with annual weeds such as knotweed and tarweed

The foregoing observations that have correlated plant succession and retrogression principles with the condition and trend of condition of meadow range do not constitute a mechanical rule of thumb for range administrators to apply blindly. They do indicate, however, that dependable guides are available if such things as the pattern of plant succession on meadows, the vegetation of the climax formation, the indicator species in the various stages of succession, and the significance of the various stages to grazing values are understood. If these guides are followed, better results will be obtained from range management in this region.

COMMON AND SCIENTIFIC NAMES

American bistort: **Polygonum bistortoides** Pursh.
Baltic rush: **Juncus balticus** Willd.
Cinquefoil: **Potentilla** spp. L.
Columbia groundsel: **Senecio columbianus** Greene.
Common dandelion: **Taraxacum officinale** L.
Douglas knotweed: **Polygonum douglasi** Greene.
Kentucky bluegrass: **Poa pratensis** L.
Littleflower penstemon: **Penstemon procerus** Dougl.
Mountain brome: **Bromus carinatus** H. & A.
Nebraska sedge: **Carex nebraskensis** Dew.
Oniongrass: **Melica** spp. L.
Ovalhead sedge: **Carex festivella** Mack.
Red fescue: **Festuca rubra** L.
Slender hairgrass: **Deschampsia elongata** (Hook.) Munro.
Slender wheatgrass: **Agropyron trachycaulum** (Schwein) Hitchc.
Tarweed: **Madia** spp. Molina.
Thin bentgrass: **Agrostis diegoensis** Vas.
Tufted hairgrass: **Deschampsia caespitosa** (L.) Beauv.
Western aster: **Aster occidentalis** Nutt.
Western yarrow: **Achillea lanulosa** Nutt.

TWO ACCOUNTS OF A TORNADO IN THE PACIFIC NORTHWEST

W. A. ROCKIE
Soil Conservation Service, Portland, Oregon

On reaching my home in Pullman, Washington, at noon on June 12, 1935, the collective youth of the neighborhood greeted me with the announcement that there was a tornado in sight, and sure enough, there was a full-grown old "Mid-west" tornado in the distance.

As nearly as my eye could judge it appeared to be about 12 to 15 miles to the northeast. It was observed from a rather poor vantage point in the northern part of the town of Pullman, Washington. I had heard that a tornado hit Pullman in 1920, but had not previously seen the positive evidence that typical tornado funnel clouds do occur in the Pacific Northwest.

Typical thunderstorm conditions prevailed on this day in the region, with dark overhanging clouds which appeared to be between 1500 and 2500 feet above the ground. The lower surface of these clouds appeared particularly black to the northeast, because of sunlit sky and less cloudy conditions directly beyond.

The tornado in question appeared to be a portion of this nearly black cloud "drawn down" into a thin column of varying diameter. Where the funnel merged onto the more or less horizontal lower face of the overlying cloud, judging its distance to be between ten and fifteen miles from Pullman, it appeared to have a diameter not exceeding 300 feet. When first seen, this diameter tapered downward with the lower half of the long funnel-like tail having an estimated diameter of not more than 50 feet. The funnel cloud appeared to be writhing much as would the body of a captive snake, sometimes dangling diagonally across between the connecting cloud above and the skyline of the Palouse hills below. Our vantage point was not sufficiently high to see definitely whether this tornado cloud reached the earth's surface or not. Occasionally the tail-like funnel twisted, assuming more or less the curly form of a pig's tail. Occasionally the entire column decreased in diameter until it appeared only as the thinnest thread; at other moments it increased in diameter until it was probably twice the minimum dimensions. These diameters changed several different times.

The climax of the entire demonstration occurred when a very pronounced thickening of the funnel appeared to be entering from the clouds above, and to continue downward most of the distance between the overlying cloud and the skyline formed by the land. It looked exactly as though a large egg were being forced downward through a dark-colored stocking which constantly became of lesser and lesser diameter downward. Finally, this bulge in the then very slender funnel appeared as though it had proved to be too large for the long slender tail through which it passed downward. This bulging portion of the cloud had a diameter at least three times that of the lower half of the funnel. The knot or bulge moved or slipped progressively downward at least four-fifths of the entire funnel length. While appearing as described, the lower end of the funnel appeared to be dragging far away from the parent or upper end. After further dragging it appeared to stretch out to so slender a thread that for a few seconds it appeared to have destroyed itself. Only the bulge (which appeared much darker than the smoothly tapering portion of the funnel) showed for a time, but about at this instant a heavy shower coming from the left (westward) entirely blotted out our view.

After the blotting out of this funnel cloud by the shower coming from the westward, I intently watched the character of the cloud ahead of the rain. The lower surface of the cloud ap-

peared approximately horizontal. Suddenly a roughness or ragged-edged lobe extended downward for from three to five hundred feet below the general cloud level. This occurred at a point at least one-half mile nearer the front of the northeastwardly moving clouds than the funnel had been. This ragged lobe was changing constantly in shape; it was increasing in size; it was elongating downward and within very few seconds a new funnel cloud had formed. This one did not last long, however, for within two or three minutes it spent itself, lost its funnel form and again was merely a ragged lower surface of the cloud.

Whether the lower end of these funnels reached the ground or not could not be determined from the writer's viewpoint, but they established beyond question that tornadoes can and do occasionally form in the Palouse country. It was learned later that the funnel cloud did not, at any time, contact the land surface.

To illustrate the fact that different people formed individual mental impressions of this phenomenon, the following description by Howard Harris, also of Pullman, Washington, is included. Mr. Harris saw the storm from a much higher hill than did the writer.

Account by Mr. Howard Harris of Pullman

"At noon on the twelfth of June, we noticed a very dark, inverted saucer-shaped rain cloud forming in the distant sky. The odd formation seemed to be about two thousand five hundred to three thousand feet above ground. Near the center of the cloud a short funnel-like projection appeared and hung like a pennant, ever growing in length and distinctness. The sky below was surprisingly clear in comparison to the overhanging cloud.

"A small hand telescope of about sixteen power helped to bring out many interesting details that were otherwise unnoticed.

"West of, and following behind the funnel, which was now probably a thousand feet long, were small funnels of the same general appearance which drifted toward the large one with increasing acceleration, until they were engulfed in it. The motion set up by the miniature funnels as they drifted toward the center of the storm greatly agitated the lower surface of the cloud, until it was ruptured in millions of places, spilling a vertically falling torrent of rain.

"As the foregoing was taking place, the body of the tornado continued to rapidly change shape and drift to the east, all the time expelling a thin cloud of water and vapor from its tip. Sometimes as the tip was lashed out to an almost horizontal position, the mist was blown away with great rapidity. Again as the funnel swung back to its nearly vertical position, the rain seemed to be pouring from the spout of a great funnel.

"After thirty or forty minutes, the funnel grew extremely long and thin, with continual writhing movement of its serpentine curves. As the rain continued, the large dark cloud seemed to wear thinner and thinner, until finally clear sky was exposed through the upper portions.

"The large funnel appeared to be in the midst of a conglomeration of many minor drafts, all blowing in different directions, but in such a way that two major drafts caused a rolling motion of the funnel-like shaft of cloud with the same movement and effect that one's hands would have upon a piece of moulding clay. The smaller drafts seemed to switch the tip of the funnel about, mostly toward the east or the direction of travel. As this switching motion continued, the shaft became extremely thin, and I should judge about 2000 feet in length, until it finally faded entirely from visibility. Following an interval of two or three minutes, a new funnel began to form, but lasted only a very short time. The total time which lapsed during the entire storm was practically an hour."

A COMBINATION TWO-WAY TRAFFIC RECORDER

BY HOMER J. DANA*

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* Credit should be given to Howard F. Clarke, a graduate student in Engineering, and to Hugo F. Libby at the State College of Washington, for their able assistance in developing the new speed recorder circuit.

The counting of traffic is recognized as a necessary and important function of the modern state highway department because funds for highway construction and maintenance can be most effectively allocated on the basis of use, or traffic volume. Consequently a considerable expense is incurred annually to determine the volume, the direction of travel, and the type and classification of users of our public roads.

Two methods are in common use for obtaining traffic data—the manual count, and the machine count. By the first method, an individual stationed at some point on the highway, tabulates complete data on all the traffic passing that point. Obviously this would be very expensive as a continuous year-round program. As a result, the machine count is employed as a continuous program for determining traffic volume, and a manual count is employed at stated intervals to determine the direction of travel, and the various classifications of traffic. Thereafter, ratio factors are applied to the machine count to obtain such data as the machine counter cannot record.

The most successful machine counter and the one most generally used at the present time, employs one or more light beams directed across the highway and into photo electric cells which in turn control, or actuate an automatic counting system. Practically all such traffic counters register the number of vehicles passing in front of them but do not distinguish as to direction.

Several years ago, the State College of Washington, in co-operation with the Washington State Highway Department, developed a special two-way traffic counter which was placed in successful operation near Colfax. Last year, by the invention of a new electrical circuit, this counter was improved and greatly simplified to the extent that two relays with three pairs of contacts have now replaced a dozen relays and three dozen pairs of contacts necessary in the original machine. Obviously, the operation and maintenance of this counter has been correspondingly improved. Incidentally, its monthly power consumption has also been reduced about one half.

In its present development, this improved two-way traffic counter includes two parallel light beams spaced 18″ apart, and directed across the highway to control the usual two photo-electric cells. These in turn control two thyratrons or vacuum tubes which function as electronic relays. When one beam is interrupted, the thyratron under its control actuates a balanced relay, which in turn selects and operates one of the two counter units. The interruption of the other light beam thereupon is of no consequence as concerns the functioning of the traffic counter. If the interruption of the light beams had been in opposite sequence, the other one of the two counter units would have been operated. Thus all rightbound traffic is totaled on one counter unit, and all leftbound traffic is totaled on the other.

After both light beams have been restored by the passage of the vehicle, and not until then, the thyratrons are automatically restored to their normal inoperative condition, ready for the next vehicle.

The new counter as operating at present, will count both pedestrians and vehicles, but since it is located in the country, the number of pedestrians is insignificant. However, by replacing the balanced relay with a special interlocking relay having four pairs of

contacts instead of two, the device becomes selective and will count only such objects as are large enough to interrupt both beams at once. It would, of course, continue to segregate the two-way traffic and count each direction separately.

The design of this new electrical circuit, which was adapted so successfully to a two-way traffic counter, came about originally in the requested development of a portable speed recorder for use by the highway traffic engineer of Washington. Such a device was needed for studying the normal flow of traffic, especially in hazardous locations, for purposes of more intelligently posting traffic control signs at such points. The same circuit, with but a trivial modification, was suitable for counting traffic.

In addition to that part of the circuit which functions as a two-way traffic counter as outlined above, there is an associated supplementary circuit element, which measures the time interval between the interruption of the two light beams, and translates it into deflection of the pointer on an electrical meter. A short time interval causes a short deflection and a long time interval causes a long deflection indicating high speed or low speed respectively.

An additional feature of this timing circuit is that a rightbound vehicle causes a current to flow through the meter in one direction, while a leftbound vehicle causes a current to flow through the meter in the opposite direction. Therefore, by using a suitable direct current type of meter with a center-zero scale, rightbound traffic will be indicated by righthand excursions, and leftbound traffic by lefthand excursions of the pointer. Obviously, the meter scale can be calibrated in terms of speed in miles per hour, rather than in terms of time units, which it is actually measuring.

If a calibrated graphic meter is employed, the resulting record will show speed and direction of each vehicle passing through the light beams of the traffic counter.

In the combined two-way traffic counter and speed recorder, each function is independent of the other so that either may be used separately, or both may be used simultaneously. In the present application, the traffic counter is employed continuously to record on a clock driven tape the separate hourly totals of traffic in each direction. Then at such times as the traffic engineer, or the highway patrol, may desire, the speed recorder is plugged into the circuit, or switched on, and a speed record is obtained of the passing traffic. Either an indicating, or a recording, instrument may be used, as desired. If an observer wishes to scrutinize the instrument without disturbing the normal speed of passing traffic, he may use an extension cord long enough to permit his withdrawing with the instrument beyond the view of the passing motorist.

It is a matter of common experience that many motorists will immediately decelerate when they observe an individual along the highway using an instrument which is apparently directed across their path, while as a rule, they will pay no attention to the same instrument if the attendan is out of view. Thus, in order to secure a record of speed which is normal to prevailing conditions at that location, it is advisable for the observer not to be in a position to attract the attention of the motorist.

Many tests were made on the speed recorder for consistency and accuracy. In repeated trials, the speed as indicated on the meter was always within one mile per hour of the figure, read by the driver, on the high grade speedometer of the test car. This accuracy is higher and more consistent than that of any other quick and practical method of obtaining traffic speed now in use.

When the traffic counter feature was checked against an eight hour manual count, the agreement was within ½ of 1%. This is considered very good.

In conclusion; the combined two-way traffic counter and speed recorder, as developed by the State College of

Washington and assigned to the Research Foundation, is relatively simple in construction, and consistent and accurate in operation. It combines two features of counting and speed recording in one unit and operates with a very low power consumption. It may be adapted to count only when both beams are interrupted at the same time, thus becoming selective against pedestrians. Its two-way feature, which is so much desired by the traffic engineer, is obtained at no cost to simplicity, and makes it unique among present day traffic counters.

OBSERVATIONS OF INCREASED MOISTURE PENETRATION UNDER COMBINE ROWS

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HERBERT A. HOPPER
Chief of Conservation Survey Party

During the course of the Conservation Survey of the Little Shasta Valley Demonstration Project of the Soil Conservation Service in Siskiyou County, California, in February, 1942, it was noted that the depth of moisture penetration on an area of Brentwood Loam soil was variable. The variation appeared to bear some relationship to the pattern of alternate bare and "mulched" strips. It was felt that perhaps here could be found local evidence in support of the practices of residue utilization and stubble mulch tillage, the introduction of which was among the principal objectives of the Demonstration Project. It was therefore decided that more intensive investigations would be made to determine if this were so, and to provide a means of presenting the finds to farmers and other interested parties.

The field in which the investigations were made is typical of an area of Class I land in the northwest portion of the project. It is normally devoted to the production of winter wheat in a two-year rotation with summerfallow. Wheat grown on this land has yielded as high as 60 bushels per acre and produces such a heavy straw that farmers claim that it is necessary to burn the straw and stubble in order to prepare the seedbed properly and get a satisfactory crop from the next seeding.

In this case a 47-bushel crop of winter wheat had been harvested in 1941, and at the time of the investigation at the end of February, 1942, the stubble had not been plowed. The crop, which was uniformly good throughout the field, had been harvested by a combine harvester and the straw and chaff permitted to run over the back end of the harvester and fall in windrows. Following harvest the entire field was burned with the result that all standing stubble was burned down to the crowns of the plants and stood only an inch or so high, providing negligible protection to the soil. The surface of the soil between the stubble crowns was left bare and exposed except in the straw and chaff windrows which did not completely burn, due to the density and nature of the chaffy material and finer straw particles. The unburned ma-

Figure 1. General view of field, looking north from excavation site, showing alternate bare and mulch strips.

terial remaining on the soil in the combine rows was in no case more than one inch in thickness and remained in relatively narrow strips approximately the width of the original windrows. Figure 1 shows the general appearance of the field at the time of the investigations.

The records of the weather station at Montague, about 16 miles south of the area, provide the following information. From July 1, 1941, to the date of investigation 12.01 inches of precipitation was recorded. This had been rather uniformly distributed except that September had been well below and December well above the average of the other months. In February, 1.36 inches of precipitation was received and occurred as follows: 1.25 inches from the 1st to 7th inclusive and .11 inch from the 18th to 24th inclusive. During the month there were only eight clear days, all others ranging from partly cloudy to rain. The temperature during this period averaged 38.2, with a maximum of 57 and a mean maximum of 49.7 degrees. Relative humidity during this period was high and evaporation low.

Superficial examinations had revealed that beneath the combine rows the soil was moist, loose and porous, while between the rows where the surface was unprotected, the soil was baked, hard and dry and showed extensive cracking. The surface inch of this exposed soil, when viewed in cross-section, was found to be laminated and vesicular in character. Figures 3 and 4 illustrate the two surface conditions found.

The detailed investigations were conducted in the following manner.

After making extensive borings to determine the depth of moisture penetration at random points throughout the field, a site was seleced as being representative of the entire field. There was a uniform slope of about one-half per cent, the combine rows were well defined, the burn had been uniformly clean and the borings indicated a typical pattern of penetration. At this point a trench was dug across several "mulch" and bare strips. This trench was dug to a depth of six feet where possible and in all other cases to the maximum depth of moisture penetration. This work was done in the rainy season and in a non-irrigated field, under which conditions it is easy to determine the approximate maximum depth of moisture penetration in this type of soil; below this depth digging is very difficult and the absence of moisture penetration was very sharp, there being no question as to when it was reached. Immediately below the point where digging became difficult the soil was noticeably lighter in color and so dry that it could not be retained in a soil auger and brought to the surface. The profile of the soil surface and of moisture penetration was determined by means of taking readings with the transit and Philadelphia rod at horizontal intervals of one foot. This information is presented graphically in Figure 2. In addition, a careful examination of the soil profile was made and plotted. A study of these graphs clearly indicated a relationship between the depth of moisture-penetration and surface conditions. The one outstanding departure from this apparent relationship was observed in the vicinity of mulch strip Number 1 where a body of gravelly sandy loam

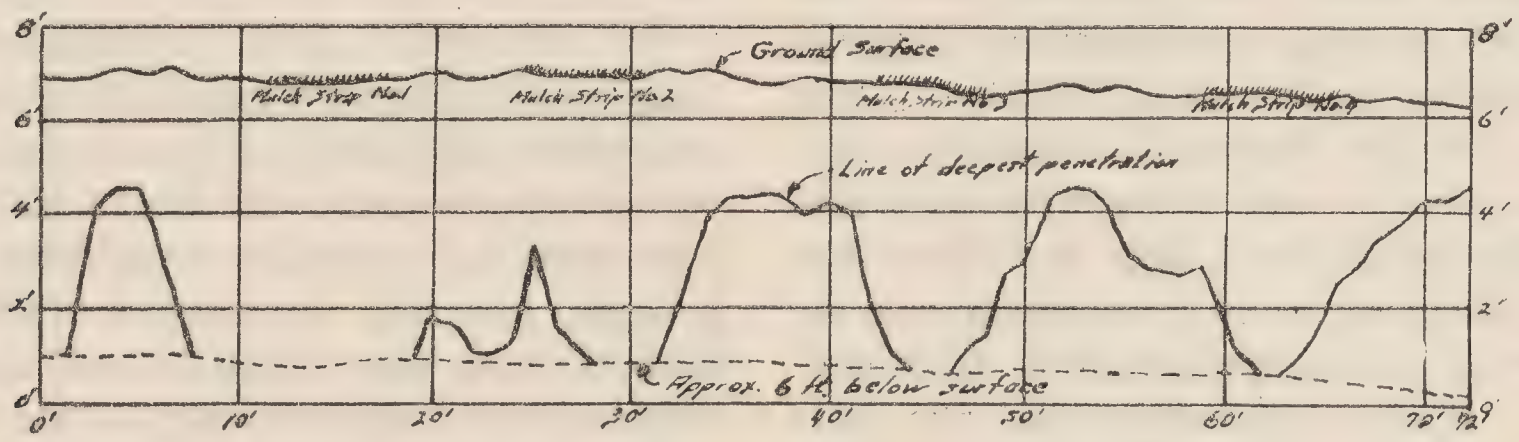

Figure 2. Profile of comparative moisture penetration under mulch and bare soil.

Figure 3. Close-up of mulch litter remaining in rows.

Figure 4. Close-up of surface of bare area where stubble burned completely.

soil was found approximately three feet beneath the surface. It seems reasonable to conclude that the presence of this very porous soil beneath the mulch strip aided in laterally dispersing moisture, resulting in the observed effect. No other sub-surface conditions were found which would appear to influence moisture penetration.

Another factor which appeared to slightly influence moisture penetration was the micro-relief of the surface, for minor variations in moisture penetration were found to occur beneath the small areas where surface moisture could not run off and had been collected. The extent and depth of this ponding apparently determined the degree to which penetration was influenced. This condition cannot be illustrated graphically, but was observed at the time of excavating the trench.

The general surface relief cannot be regarded as a factor in the shallower penetration under the bare surface. A string stretched across a number of windrows and bare strips showed that the combine rows were slightly higher in elevation than the bare areas, thus apparently eliminating the possibility of lateral surface movement of water from the latter to the mulch strips. Also cultural and harvesting operations had formed a series of small ridges parallel to the combine rows. These appeared to have a tendency to conduct surface water off the field between the windrows. While there was evidence of this runoff, no measurement or determinations of the amount could be made.

Following the discovery of the gravelly body which apparently influenced the moisture penetration, still further borings were made to determine the extent and location of this body and to obtain further confirmation of the conditions observed in the preliminary series of borings and the excavation. Approximately 70 additional holes were bored in an area approximating the length of the trench and extending forty feet north and sixty feet south of the trench. Except where there was an apparent departure from the uniform slope, and in the area influenced by the body of gravelly sub-soil, moisture penetration was found to be comparable to that observed in the excavation.

To determine the approximate amount of mulch that had resulted in the observed conditions, the average weight of the mulch material was determined in the field. A line running across the four mulch strips which were intersected by the trench was selected at random approximately fifteen feet north of the trench, where there had been little or no trampling or disturbance by the other investigations. Quadrats five feet square were laid out on this line in each of the four mulched strips and the mulch material removed as completely as possible by hand and weighed. The average weight of the mulch from the four quadrats was .1175

pounds per square foot, which equals 2.56 tons per acre. However, the material when weighed was not entirely air dry, that in contact with or near to the ground surface being considerably wetter. Also, the mulch consisted principally of the hulls, waste grain and other heavier portions of the straw and chaff material left by the harvester.

The observations made can be summarized as indicating that where surface and sub-surface conditions are otherwise conducive to deep moisture penetration the use of a relatively light covering of crop residue as a surface mulch will materially increase the amount, and therefore the depth, of moisture penetration. This conclusion supports on a field basis in this area the observations and findings of controlled research in other sections.

EDITORIAL CHANGE AND FUTURE PLANS

Members of the Northwest Scientific Association:

These are days that try men's souls in many ways. War is an individual as well as a group tragedy. In the autumn of 1942 the council of the Northwest Scientific Association found it necessary to abandon the annual meeting of the society for the duration. When Dr. H. F. Raup left for war duties in Washington in the spring of 1943, Dr. O. W. Freeman took over the duties of secretary-treasurer. This late summer Dr. Freeman was granted leave of absence from the Eastern Washington College of Education to teach Geography to army cadets at Indiana University. After correspondence, the council has asked J. W. Hungate at Eastern Washington College of Education, Cheney, Washington, to serve as secretary-treasurer during the emergency. Meanwhile Dr. Freeman, after five years of service as secretary and five more years as editor, finds it impossible to edit NORTHWEST SCIENCE at so great a distance and with a heavy teaching load. The council hopes that the publication of Northwest Science can be continued, if a new editor can be found. It will be necessary to receive more articles of the right standard than have been recently submitted. Pending the appointment of an editor, it is suggested that any of you who have manuscripts ready for publication in NORTHWEST SCIENCE send them to Mr. J. W. Hungate, who will forward them to the new editor. While advertising pays a portion of the cost of publication it will be necessary to collect annual dues of one dollar in order to properly finance continued publication. Membership in the organization will help to keep the Northwest Scientific Association a "going concern" even during the war. Certainly the past record of the association is such as to justify the expectation that the Northwest Scientific Association will fill a still greater service in the post-war construction period, than it has filled in the past. The counselors of the association have approved the assessment of dues for 1943. What funds, derived from the collection of dues, are not used in the publication of NORTHWEST SCIENCE will be jealously guarded to reactivate the society as soon as the war is over. If you are interested in helping to keep the organization functioning you can save us paper, postage and time by sending to Mr. J. W. Hungate the sum of one dollar. Those of us who are following the industrial and agricultural contributions of the Pacific Northwest to the war effort, can project into the future the part which the Pacific Northwest will play in the post-war period. I believe it a matter of regional pride to support the Northwest Scientific Association during the war, so that the association may serve as the nucleus about which to organize the increased number of teachers of science, industrial science workers, governmental scientists, etc., which will be present in the region after the war. The counselors of the Northwest Scientific Association are pledged to bring the organization into full activity just as soon as possible after the war emergency has passed. Each of you as a dues-paying member can help to keep the association from becoming a war casualty. I trust that each of you will do your small part.

J. W. SEVERY, President.

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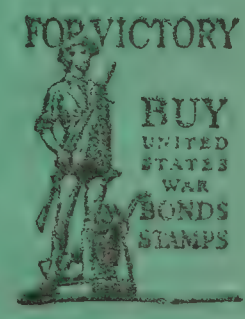

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February 1944

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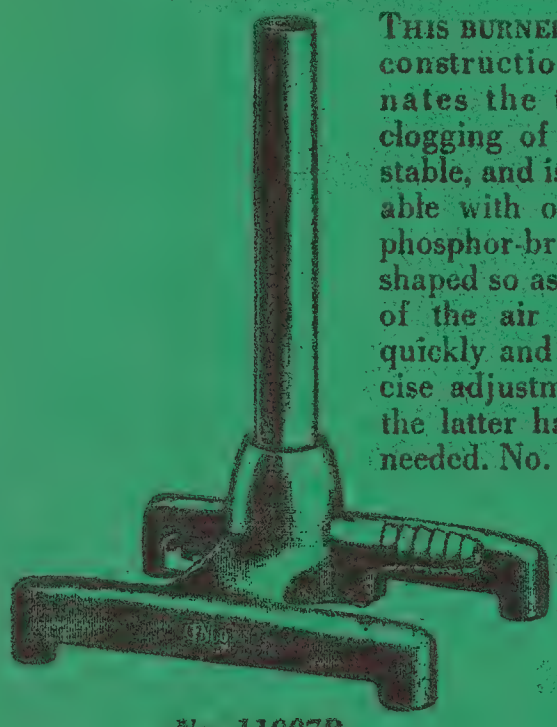

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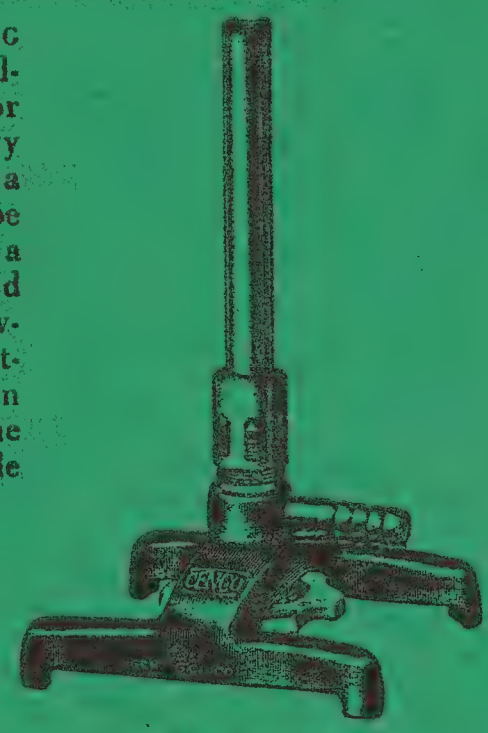

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NORTHWEST SCIENCE

Volume XVIII

1944

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Published quarterly by the Northwest Scientific Association

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL.XVIII, NO. 1 FEBRUARY, 1944

Published April 15, 1944

Editor, JOHN EHRLICH, University of Idaho, Moscow

TO THE MEMBERS OF THE NORTHWEST SCIENTIFIC ASSOCIATION:

As was indicated in the November issue of NORTHWEST SCIENCE, war conditions have developed problems which probably would never have arisen had it been possible to continue the annual meetings even during the war period. I am happy to say that Dr. John Ehrlich of the University of Idaho has consented to serve as the editor of this issue of NORTHWEST SCIENCE, and that we have reason to believe that it will be possible to maintain its publication during the rest of the war period providing that each of you will contribute a dollar as dues for 1944, recognizing that the funds acquired by the payment of dues will be used to continue the publication of NORTHWEST SCIENCE. I believe that each of you engaged in some sort of scientific activity owes it to the field of science to do your part to maintain organizations which tend to bring scientists together in their field of common interest, and at the same time educate the public to a better realization and understanding of what science is contributing to the modern world. If you believe that the Northwest Scientific Association has in the past helped to do this you should by all means support the organization now so that it may be ready to go into "full speed ahead" when the war is over. Won't you please respond to that impulse and send immediately to Professor J. W. Hungate, Department of Applied Sciences and Arts, Eastern Washington College of Education, Cheney, Washington, a dollar for membership dues?—J. W. SEVERY, *President.*

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HISTORY OF THE OREGON ACADEMY OF SCIENCE

F. A. GILFILLAN

Secretary, Oregon Academy of Science

Although the National Academy of Science was not established until 1863, there existed in America other scientific organizations much earlier than this. The Philadelphia Academy of Natural Science celebrated its centennial in 1912. Also there are numerous state academies of which the California Academy of Science, dating from 1853, is the best known in the West.

On January 6, 1892, under the leadership of P. C. Eastwick of Portland, there was organized the Science Club of Portland, which became incorporated in December of that year as the Oregon Academy of Sciences. The officers of this early organization were: Dr. A. E. Rockey, president; Dr. H. D'Arcy Power, first vice-president; P. G. Eastwick, second vice-president; Prof. J. Burnham, third vice-president; B. R. Baumgardt, secretary and treasurer; M. W. Gorman, B. S. Pague, C. F. Jewett, members of executive committee; P. G. Eastwick, librarian; M. W. Gorman, assistant librarian, and Dr. H. D'Arcy Power, curator.

Meetings were held monthly at which scientific lectures were delivered. The titles of these early papers follow: "The Electrical Transformer," W. C. Cheney; "The Development of Astronomy in the Last Four Centuries," B. R. Baumgardt; "The Microbic Origin of Disease," A. E. Rockey; "Glimpses of Past Civilization at Intervals of One Thousand Years," H. D'Arcy Power; "Topography of the Upper Columbia," Wm. Cuthbert; "The Evolution of Man," John Fiske; "Heredity—A Study in Phycology," J. Burnham; "The Spectroscope," Rev. Father O. Summer; "The Nebular Hypothesis," B. R. Baumgardt; "The Formation of the Earth's Crust," Prof. Leonard C. Cochran; "The Succession of Plants," Prof. Henry Bolander; "The Origin and Distribution of Animal Life," Prof. F. L. Washburn; "The Advent of Man," Dr. H. D'Arcy Power; "The Development of Mind," Prof. J. Burnham; "The Growth of Civil Institutions," Prof. Frederick Young; "Practical Meteorology," B. S. Pague; "Is the Position of the Humane Society on Vivisection Truly Humanitarian," A. E. Rockey; "The Condition of the Atmosphere in the Carboniferous Period," H. D'Arcy Power; and "The Food Plants of the American Natives West of the Rocky Mountains from Mexico to Alaska," M. W. Gorman.

The constitution and by-laws of this early Academy provided for the eventual establishment of a museum. Some donations were actually received, particularly in the fields of entomology, geology and paleontology. The charter of the corporation provided that should it, at any future time, fail to continue its proposed work or allow its charter to become forfeited its collection and library should revert to the City of Portland to be placed by it in some public institution for general use and benefit. The organization at the end of 1892 numbered 115 members.

The records of the Corporation department in Salem show that the Academy was dissolved on August 6, 1910, in order to make way for a new Oregon Academy of Science, which received its charter on August 18, 1910. The incorporators were J. D. Lee, president; Frank W. Power, secretary-treasurer, and A. W. Miller, curator and librarian.

The state press, particularly in Portland carried between 1892 and 1912 numerous newspaper accounts of meetings of these two organizations, both in Portland and other towns of the Willamette valley. The papers were always on subjects of general interest rather than in highly specialized fields. No records appear of activities of the Academy after 1912, and the name was dropped from the Portland city directory in 1914.

On April 3, 1943, in Corvallis on the occasion of the Fifth Annual Biology Colloquium, a group of scientists gave

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consideration to the desirability of reorganizing the old Oregon Academy of Science. A committee was appointed to investigate the needs of science in Oregon, and if it were considered feasible, to proceed to lay plans for such a reorganization and to report back at the time of the meeting of the Pacific Division of the American Association for the Advancement of Science in Corvallis on June 14-19, 1943. The committee appointed consisted of Dr. A. Knowlton, physics, Reed College; Dr. D. B. Charlton, chemistry, representing industry; Dr. Warren D. Smith, geology, University of Oregon; Dr. C. R. Monk, zoology, Willamette University; Dr. H. P. Hansen, botany, Oregon State College, Mr. Stephen N. Wyckoff, U. S. Forest Service, Portland, Mr. Leroy Childs, Hood River Experiment Station, representing agriculture, and Dr. F. A. Gilfillan, science, Oregon State College, chairman. Due to the cancellation of the AAAS meeting scheduled for Corvallis the committee did not convene until October 16, 1943, when it gathered in the office of Mr. Wyckoff in Portland and recommended the adoption of a constitution based upon the constitutions of the state science academies of California and of Ohio.

Final organization of the Academy was effected on October 27, 1943, on the occasion of Oregon State College's Diamond Jubilee. Officers were elected at that time to serve until the first program meeting which was planned for January in Portland. These first officers were as follows: Dr. A. L. Strand, Oregon State College, president; Professor J. S. McGrath, University of Portland, president-elect; Dr. F. A. Gilfillan, Oregon State College, secretary (for a two-year term), and Dr. R. R. Huestis, University of Oregon, treasurer.

In accordance with these plans the first program meeting was held in Portland, on Saturday, January 15, 1944. Dr. Strand presided. An address of welcome was given by Commissioner Dorothy McCullough Lee, representing Mayor Earl Riley of the city of Portland. Papers were delivered in five divisional meetings, as formal sections of the Academy had not yet been organized, a total of 39 papers being presented. In the 4 o'clock business meeting, officers for 1944 were elected as follows: Prof. J. S. McGrath, University of Portland, president; Mr. Stanley Jewett, U. S. Fish and Wildlife Service, president-elect; Dr. R. R. Huestis, University of Oregon, treasurer, re-elected.

Provision was made for the organization of sections in Biological Sciences and in Geology and Geography, and officers for the latter section were elected as follows: Dr. Warren D. Smith, University of Oregon, chairman, and Dr. Ira S. Allison, Oregon State College, membership chairman. The general meeting held in the evening was open to the public. On this occasion, Mr. Ivan Bloch of the Bonneville Power Administration delivered the address on the "Application of Power to Postwar Industrial Development in Oregon." At the close of this address, Professor McGrath took over the gavel as president of the Academy for 1944.

The purpose of the Academy is best set forth by President Strand as follows: "War-time emphasis on science, together with the imminent postwar industrialization of the state, has created an interest in, and a demand for, scientific information that only such a state organization can supply. To meet this demand, both now and in the future, the Oregon Academy of Science pledges its all-out support to our great Commonwealth."

The interest of scientists in the state of Oregon gives assurance that the Academy is now launched on a permanent foundation and will continue to render valuable service to the state of Oregon.

SOCIAL WORK

M. E. HOLCOMB

Assistant Professor, Graduate School of Social Work, State College of Washington

It may seem anomalous to include an article on social work in a journal devoted to the sciences. To the writer's knowledge, no one has ever held or maintained that social work is a science: its practice is often called an art, but its content has aspects which may possibly be regarded as approaching the scientific.[1] If science is, as defined in *Webster's New International Dictionary*, a "study which is concerned with observation and classification of facts, especially with the establishment of verifiable general laws, chiefly by induction and hypothesis," then social work has been for the past quarter of a century increasingly scientific in its theoretical formulations and is constantly adding and arranging data from which its existing and future hypotheses may be tested.

The social worker is frequently asked "what is social work?" It is extremely difficult to answer this question satisfactorily, just as it is difficult to define adequately any profession; however, we may say that the function of social work is to help the individual who is experiencing difficulty in coping with his own relations to social situations and requirements. These difficulties may be due to external factors over which the individual may or may not have control, such as wars, industrial depressions, the loss of his job or the death of his wife; or they may be due to factors within the individual, as physical or mental disabilities or emotional disturbances which make it difficult or impossible for him to hold his job or his wife. Or the difficulty may be due, as is most frequently the case, to combinations of extrinsic and intrinsic factors which vary widely in their quantitative and qualitative relations to the whole. To aid the individual, the social worker may work directly with him to help him change the situation or his reactions to it; he may work with a (relatively small) group of persons to help them gain experience in meeting certain problems; or he may attempt to change the situation itself and by thus removing or altering the difficulty make it possible for the individual to continue his previous satisfactory course. Again, in many cases the social worker must utilize more than one method.

Critics of social work frequently suggest that it is the structure and functioning of our society which need changing for it is these which, in their opinion, create the difficulties which the individual must try to overcome, and maintain further that to focus upon the individual in trouble is futile and wasteful. Granting that there are many aspects of our socio-economic system which could well be modified, it is our feeling that we cannot afford to ignore the individual who is affected while these changes are being brought about. By way of analogy, we will all admit that the source or sources of a typhoid epidemic must be discovered and eliminated, but at the same time it is extremely important to give adequate medical attention to those individuals who become infected before the more important objective can be obtained. We may go further in answering our critics and point out that not all the individual's difficulties can be traced to broad socio-economic factors: in every society known, and there are many of them, there have been some individuals who could not or did not achieve a satisfactory adjustment.[2] It seems to be true that human beings cannot live together without some friction and hostility and these inevitably engender situations which affect the personalities of the individuals involved.

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[1] A recent account of the development of the scientific aspects of social work may be found in Bertha C. Reynolds, *Learning and Teaching in the Practice of Social Work*, N. Y.: Farrar & Rinehart, 1943, pp. 20-30.

[2] The writer is well aware of the tremendous influence on social change that many persons who were poorly adjusted socially have had. It is not his contention that the aim of social work is to help *all* such persons achieve such adjustments: the social worker can try to help only those persons who are dissatisfied and unhappy in their adjustments and who *want* such help in effecting change.

It should be stressed that the principal, indeed the only, function of social work is to help those individuals with some social problem, who want and can accept such help, even though the primary cause of that problem lies within the individuals involved. It is this concept which draws the line, sometimes tenuous, between social work and psychiatry.[3] The person who attempts to deal with emotional or mental disturbances solely as manifestations of a disordered personality is working in the field of psychiatry.

While social work and psychiatry are separate entities, social work has drawn heavily on the latter profession in its efforts to understand and explain the material with which it works, viz., the human being in his social situation. As long as social workers accepted the prevailing cultural concept that man is a rational organism, capable and free to react and make his decisions on the basis of what he consciously knows or believes to be true, their efforts to help remained in the "lady bountiful" stage and justified to some degree the charge that they were the tools of those who wished to exploit their fellow men. It was not until social workers began to accept and understand the concept that man is largely an irrational being[4] whose reactions and decisions are frequently and largely influenced by attitudes and beliefs of which he is unconscious, that they were able to function effectively. We have learned, slowly, sometimes reluctantly, and as yet inadequately, that very frequently it is the individual's emotional reaction, based on his unconscious feelings, to the situation which is really important rather than the situation itself. For example, the request of a mother that her two adolescent daughters be placed in an institution so that they might be saved from gross immorality was found to be based on her own unconscious feelings about femininity and sexuality rather than on any danger confronting the daughters: they and their social relations were typical and healthy.

To understand fully a man and his personality is not enough, however, for the social worker. Man lives in a certain society or societies and is a product of that culture and subcultures. In our time it has come to be widely accepted that western civilization has changed and is changing and that the individual may well find more security by belonging to and participating in a group than by attempting to operate on an individualistic basis and at the same time the resulting diminuation of insecurity gained by this participation adds to his status and self-valuation:[5] the paradox, that the individual in our society has at the same time become less important and more important, seems true. Consequently, it is necessary for the social worker to know and understand our culture and related and contrasting cultures, to be familiar with the various phenomena associated with group activity and the changes brought about as a result of the interplay of group and individual forces. Political and economic structures certainly affect and are affected by the individual man and his family; the legal framework of our country also impinges on most of our activities: the social worker, therefore, must be familiar with these aspects of our society if his work is to be constructive and not constantly running counter to forces which are much stronger and, in the legal situation, the expression of the attitudes of the body politic.

Most fundamentally, man is a biological organism subject to all the vicissitudes that affect living things. We must, then, understand his structure and function (in the biological sense) and be aware of and somewhat familiar with the physical ills which beset him. This is not to say that the social worker is a physician: the social worker has enough to do without appropriating the functions of other professions. But these illnesses, defects and deficiencies do affect the individual's social adjustment

[3] Charlotte Towle, "Phychoanalytic Orientation in Family Case Work," *American Journal of Orthopsychiatry*, XIII, 1943, pp. 12-18.

[4] An excellent exposition of this point of view may be found in Franz Alexander, *Our Age of Unreason*, Philadelphia: J. B. Lippincott, 1942, pp. 141-212.

[5] Witness the vast number of associations, societies, clubs, conferences, etc., formed and being formed in this country.

and must be taken into account in helping him to improve the adjustment or his feelings and attitudes toward it.

Lastly, the social worker himself is a human being, a member, together with his clients, of the same society with all its cultural, economic, political and legal ramifications, and subject to the same biological laws. This means, of course, that it is essential that the practitioner in this field has the most complete self-understanding possible: this includes an understanding of his own irrational drives and needs and the way he relates himself to people. Without this last understanding it may be impossible for him to create a situation in the interpersonal relationship with his client wherein the latter is free to work out his own problem.

Prior to the creation of the Federal Emergency Relief Administration in May, 1933, social work based on professional standards was confined almost exclusively to the large cities of the country. With the establishment of the Federal and the several State Emergency Relief Administrations there was created a vast and sudden need for persons to administer this assistance and there were too few people, by far, to fill the positions. This resulted in an influx of literally thousands of persons unequipped by training, experience and (in many cases) social point of view who became known automatically as social workers. As the depression and its aftermaths lingered, the various emergency agencies were either supplanted by or developed into permanent public welfare organizations on federal, state and county levels, and the supply of qualified social workers has never yet approached the demand. It is as if a tremendous epidemic had forced into service all persons who could possibly act as nurses and then lingered on and on, creating a continuing demand for qualified nurses but never making it possible for enough persons to be trained adequately for this purpose. This would create a situation in which many persons who had no nursing qualifications would be known as nurses and in which the general public's ideas about what should and could be done in the field of nursing would be grossly distorted. This is practically what has happened in the field of social work.

The profession of social work is the only one in this country which has consistently and from the beginning, insisted that its training schools be on a graduate basis exclusively.[6] This means that all students in schools of social work shall have been awarded their bachelors' degrees (exceptions may be made in a limited number of cases for those persons who lack only a few hours of receiving their baccalaureates and those whose maturity and experience make it obvious that they can creditably do the work of the school; in the former case, no graduate credit is allowed until the student completes the work for his undergraduate degree, in the latter no graduate credit is allowed). The forty-six schools which comprise the American Association of Schools of Social Work are uniform in requiring two academic years of work for the master's degree, which is the professional degree in this field. Because of the great demand for workers, however, the majority of students leave school at the end of their first year and work in a professional agency for a period of time before returning to complete their work. This fact has led six schools in the Association, of which the Graduate School of Social Work of the State College of Washington is one, to offer only the first year of graduate training. In addition to the facilities for study and training mentioned above, a few of the schools also award the Ph.D. degree in social work.

To prepare the graduate student for the tremendously important and difficult work he will be called upon to do in social agencies (for we are coming to understand better how easily the social worker can damage, sometimes irreparably, the client's abilities to make his necessary adjustments) three broad areas of studies and training are neces-

[6] Esther Lucile Brown, "Comparative Developments in Social Work, Medicine, and Law," *The Family: Journal of Social Case Work*, XXIV, no. 7, November, 1943, pp. 243-55.

sary. There are certain background and informational courses required so that he may better understand why situations are as they are and thus be more able to plan to meet and cope with them; to broaden his knowledge of the legal, social and political structures within which he must work; and to give him some understanding of individuals in their physical, mental and emotional structures and deviations. The second area is that of agency purpose, structure, administration and its relation to the community, be it city, county, state or nation, in which it is organized and which it serves. The other group of studies, without which the others are relatively meaningless, is that of social case work and group work in which the student has class room and field work experience in actually learning and assimilating the what, why and how of working directly with people who are experiencing some difficulty in their social situations. These three areas of study have many subdivisions and specializations but most workers and teachers are agreed that the first year of such study should be broad and so devised as to give the student a thorough grounding in the generic aspects of social work, while the more specialized aspects may well be deferred to the second year. This is not the place to discuss the degree of perfection to which the curricula of the various schools of social work have attained, but we might point out that the schools themselves and the Association of Schools are constantly studying and attempting to improve the curricula and the methods of instruction.

Two factors have combined recently to shake what complacency we may have had in this whole area of professional training and practice in social work. One of these is a fact that we are just now admitting, although it has been apparent for some time; there is and will be for an indefinite period in the future a greater demand by agencies for social workers than the existing and prospective schools can possibly supply, and there are various degrees of social adjustments out of balance and many reasons for these inbalances and, furthermore, different degrees of knowledge, training and skill are required for handling them. The other factor is that many young people who wish to go into social work as their career are very poorly prepared for their graduate training even though they may have a degree from a college or university of excellent caliber. The system of majors and minors which prevails in most colleges may and frequently does prevent the student from securing the broad background which he needs for understanding and working with people.

Recognition of these two more or less independent situations had led several schools of social work to study and experiment with undergraduate curricula which they hoped would, to a degree at least, prove to be an answer to both difficulties. The American Association of Schools of Social Work then appointed a Committee to study this whole area: as a result of these experiments and this study[7] definite recommendations and criteria have been formulated and the near future may see many such curricula established to give the undergraduate who plans on becoming a social worker a better and more well-rounded background and to train these same undergraduates for positions which do not require the understanding and skills of the more specialized positions. The Graduate School of Social Work of the State College of Washington is planning such a pre-professional curriculum leading to the Bachelor of Arts in Social Work along the lines marked out by the Association of Schools.

This is not the time nor is there space here to outline this curriculum in detail. It might be well, on the other hand, to outline the content: over half the courses necessary for the bachelor's degree in social work will be required in the following departments: anthropology, economics, English, history, philosophy, physiology, political science, psy-

[7] *Report of the Committee on Pre-Social Work Education: American Association of Schools of Social Work.* Chicago: A.A.S.S.W., 1944.

chology, social work, sociology and zoology. The remainder of each student's course of studies will be decided upon in conference between the student and an adviser from the faculty of the School and will be selected largely from the departments just mentioned and from home economics, police science and administration, public health and related departments and schools. It is recognized clearly that this proposed curriculum is somewhat experimental and will probably have to be revised as we gain more experience from which we may draw conclusions, but we do believe that it will be at least a long first step toward bridging the gap that has separated the graduate schools of social work and social work agencies on the one hand, and undergraduate students on the other.

Social work is pragmatic: it borrows and adapts knowledge and skills from other professions which offer promise of increasing its own ability to do its job, it is constantly devising new and (hopefully) better ways of doing things. The social worker is sometimes reproached for not being more scientific and for using tools which work without being fully and completely aware of how and why they work. To this we may say that in the profession of medicine we have honored and valued company. We may also reply that there is so little really known about man, from any point of view, and so much to be done that our first responsibility is to try to do the job on a pragmatic basis and then try to determine from our experiences whether or not our efforts and the results of those efforts can be explained and interpreted on the basis of rational hypotheses. Many of us believe that this can be done, but we are not willing to wait for the hypotheses before we attempt to apply the tools we have at hand.

TWO NEWLY DISCOVERED GENERA AMONG THE CONIFEROUS WOODS OF THE WESTERN TERTIARY

GEORGE F. BECK

Professor of Geology; Chairman, Science Division, Central Washington College of Education

Two genera of coniferous wood, apparently not listed among the Tertiary woods of the western states, have been recognized in the Percy Train collections from Rainbow Ridge, northwestern Nevada. These two, *Tsuga* (hemlock) and *Chamaecyparis* (cedar) bring up to 14 the genera of coniferous wood more or less certainly identified from the period and area in question. The previously known (to me) list, briefly annotated is presented:

1. *Abies* (true fir)—rare in Washington and Nevada Miocene.
2. *Cedrus* ("cedar" of Lebanon)—early Tertiary of the Pacific Coast.
3. *Cupressus* (California cypress) — Mojave Miocene.
4. *Ginkgo* (the near-conifer maidenhair tree)—rare in the Washington Miocene.
5. *Keteleeria* (Japanese "fir")—early Tertiary of the Pacific Coast.
6. *Libocedrus* (incense cedar) — California, Eocene (?)
7. *Picea* (?) (spruce)—extremely difficult to distinguish from the Douglas fir when poorly preserved but undoubtedly present.
8. *Pinus* (pine)—many horizons and localities in many varieties, more abundant in the early Tertiary.
9. *Pseudotsuga* (Douglas fir) — many localities and horizons.
10. *Sequoia* (redwood) — common in most localities and horizons.
11. *Taxodium* (?) (swamp cypress)—rarely to be distinguished from redwood but undoubtedly present.
12. *Taxus* (yew)—one log known from the Vantage, Washington Miocene.

Among these fossil woods, and *Tsuga* included, traumatic duct rows occasionally occur in 1, 2, (7?), 9, and 10, as in their modern counterparts.

The Rainbow Ridge specimens referable to the modern genus *Tsuga* bear a

close resemblance to the native hemlock, *T. heterophylla*. To be cited as points in this resemblance are, (1) the tendency to produce traumatic duct rows, (2) fairly abundant terminal parenchyma strands, and (3) occasional reduction of ray tracheids to mere traces or interspersal with parenchyma cells. As a definite family character the normal ray cells are thick-walled and clearly marked with abietineous pitting.

The Rainbow Ridge cedars (Chamaecyparis) resemble closely the modern *C. nootkatensis* in, (1) the frequent low rays composed entirely of tracheids, (2) the presence of tracheids on the margins of occasional rays, and (3) the paucity of wood parenchyma. Generic characters include, (1) low rays, (2) comparatively abundant pitting on the transverse ray-cell walls, (3) smooth and non-indentured tangential end-walls of same, (4) irregularly thickened transverse walls of wood parenchyme cells, and (5) tracheids squarish in outline (cross-section).

STATUS OF TERTIARY WOODS OF THE WESTERN STATES REPRESENTING THE JUGLANDACEAE

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For many years there has been uncertainty concerning the generic status of some fossil leaves belonging without question to the walnut family as a whole. A review of the woods of *Juglandaceae* as they have appeared in Tertiary horizons of the western states has suggested which genera are present, and in what proportions their leaves (or other remains) might be expected to appear. The fossil woods of the walnut family as they are known to the writer from the western Tertiary are given:

1. *Carya* (hickory) — the genus most abundantly represented by specimens but confined apparently to the mid-Tertiary. The ring-porous members are readily identified, but the diffuse-porous types are with difficulty separated from true walnut (by higher, narrower rays) when the pith is wanting. Many varieties.
2. *Pterocarya* (Chinese "walnut") — most widely distributed member of the family, apparently into the early Tertiary. Several or more species, all characterized by strictly diffuse and en echelon alignment of the pores. Detail fine including the narrow 1-2 seriate rays. Crystals wanting. Pith chambered as in the true walnuts.
3. *Juglans* (walnut)—abundant in the Miocene Vantage petrified forest of Central Washington in a form akin to the black walnut, *J. nigra*. Known elsewhere but from one specimen from the Oregon Gray Ranch Miocene. Pith as yet undiscovered.
4. *Engelhardtia* (section *Oreomunnea*, with annual ring present)—a single specimen has been encountered among the woods of the Chehalis, Washington (Eocene?).

Never arriving at numerical dominance (though relatively abundant in the Vantage forest), the inferior position of the woods of the Juglandaceae in the western Tertiary bears out the critical attitude of modern paleobotanists towards the numerous "*Juglans*" species that were created by the early workers on fossil leaves. Granting that fossil leaves and woods often fail to match closely, even when directly associated, this study also lends likelihood to those instances where "walnut" leaf impressions have been transferred from *Juglans* to *Carya* or *Pterocarya*. For modern, comparative material the writer is indebted to Dr. S. J. Record for loan of the Yale collection of wood sections from the *Juglandaceae* and to Dr. I. W. Bailey of Harvard for limb sections of the same.

NOTES ON CRONARTIUM OCCIDENTALE

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Cronartium occidentale Hedcock, Bethel, and Hunt, the piñon blister rust, is a heteroecious rust indigenous to the western part of the United States. The pycnial and aecial stages of the rust develop on the piñon pines, *Pinus edulis* Engelm. and *P. monophylla* Torrey and Fremont, and the uredial and telial stages on the leaves of several species of ribes.[1] The stages on the ribes leaves are so very similar to those of the white pine blister rust, *Cronartium ribicola* Fischer, an introduced heteroecious rust which has its aecial stage on the various species of five-needle or white pines, that they can be distinguished only by means of extensive urediospore measurements (Colley, *1925*), by carefully controlled differential microchemical tests (Acree, *1937, 1941*; Hahn, *1930*), or by inoculation of differential ribes hosts (Hahn, *1928*) or pine hosts.

Since the white pine blister rust is now generally established in the white pine forests of western Montana, Idaho, Washington, British Columbia, Oregon, and northern California, there are areas in which the two rusts may be found together. Also, because of the general similarity of the two rusts, especially on ribes, it seems desirable to publish the following information regarding the location, spread, and life history of the piñon blister rust. This information has accumulated incidental to several years of scouting for the white pine blister rust in the West by members of the Office of Blister Rust Control of the United States Department of Agriculture.

GEOGRAPHICAL RANGE AND HOSTS

Hedgcock, Bethel, and Hunt (*1918*) first described *Cronartium occidentale* and gave data concerning its geographical range. They reported the rust on *Pinus monophylla* at Prescott, Ariz.; on *P. edulis* at six locations in Colorado; on *Ribes aureum, R. odoratum,* and *R. reclinatum* X *R. hirtellum* in Arizona; on *R. aureum, R. inebrians,* and *R. leptanthum* in Colorado; and on *R. aureum* in Kansas. They also record successful inoculation of *R. americanum, R. aureum, R. giraldi, R. malvaceum,* and *R. nigrum.*

Rhoads et al. (*1918*) reported successful inoculation of *Ribes sanguineum* and *R. inerme.*

Blasdale (*1919*) reported this rust as abundant near Monrovia, Calif., on *Ribes tenuiflorum.* This was the first report of the presence of the rust in California.

Hotson (*1925*) recorded the collection of this rust at Spokane, Wash., by W. E. Flowers in 1912 on *Ribes aureum* and in 1914 on *R. odoratum.*

Garrett (*1919, 1937*) reported the first collection in Utah on *Pinus edulis* in 1918. He also reported the first collections of the rust on *Ribes aureum, R. odoratum,* and *R. inerme* in Utah. Garrett (*1921, 1937*) published two additional locations for the rust on *P. edulis* and additional new locations in Utah for the rust on *R. aureum, R. inebrians,* and *R. leptanthum.*

Arthur (*1934*) summarized the States and hosts for all collections which had been reported up to 1934, but the collections recorded below had not been reported, hence are in addition to his summary.

NEW GEOGRAPHICAL RANGE AND HOSTS

In April, 1919, a Cronartium on ribes was reported in a nursery at Pasadena, Calif. Upon investigation the infected plants were found to have been a recent shipment from a nursery at Monrovia, Calif. Inspection of the wild ribes in the vicinity of the nursery also revealed a heavy infection with apparently the same rust. The discovery of this Cronartium immediately raised the question whether or not it was the white pine blister rust. Because of these findings

[1] The terminology of Standardized Plant Names (Kelsey and Dayton, *1942*) is used in referring to currants and gooseberries.

an extensive program of scouting was carried out during the summers of 1919, 1920, and 1921 in the Western States by members of the Office of Blister Rust Control, United States Department of Agriculture. The scouting disclosed that, whereas white pines growing in association with Cronartium-infected ribes were always uninfected, piñon pines growing in association with Cronartium-infected ribes were often infected. Hence it was definitely established that the rust was the native *Cronartium occidentale* which had been reported by Bethel and Posey (*1921*).

Following are first reports of new locations of the piñon blister rust found during the scouting seasons of 1919 to 1921, inclusive, unless otherwise indicated.[2]

CALIFORNIA

Pinus monophylla.—Alpine Co.: occasional at Wolf Creek 8 miles south of Markleeville and at Centerville; 15 per cent infection on the East Branch of Carson River. *Mono Co.*: infrequent at Bridge Co. Farm, Chris Flat, Mono Lake, West Walker River, and Yancy Canyon; 40 per cent infection on Desert Creek in Sweetwater canyon and 95 per cent at Toll House.

Ribes aureum.—Los Angeles Co.: Arcadia, Clearwater Creek, Monrovia, and Pasadena. *Mono Co.*: Bridge Co. Farm, Bridgeport, and Chris Flat.

Ribes cereum.—Mono Co.: Bridgeport, Centerville, Chinaman Flat, Sweetwater Canyon, and Toll House.

Ribes divaricatum.—Alpine Co.: Centerville and Markleeville. *Mono Co.*: Bridgeport and Sweetwater Canyon. *Nevada Co.*: Hobart Mills. *Placer Co.*: McKinney.

Ribes gracillimum.—Los Angeles Co.: Aqua Dulce School, Burbank, Los Angeles, La Tuna Canyon, Monrovia, Newhall, Oaks Garage, Pacoima, Pico Canyon, Placerita Creek, Roscoe, Sand Canyon, Tapia Canyon, and Tujunga.

Ribes hesperium. — Los Angeles Co.: Monrovia.

Ribes indecorum. — Los Angeles Co.: Monrovia.

Ribes inerme.—Alpine Co.: Centerville. *Mono Co.*: Mt. Jackson near Bridgeport.

Ribes lasianthum.—Alpine Co.: Markleeville.

Ribes malvaceum. — Los Angeles Co.: Monrovia.

Ribes nevadense.—Mariposa Co.: Wawona. *Yosemite National Park*: Snow Creek and Woodfords.

Ribes nigrum.—Los Angeles Co.: Monrovia.

Ribes odoratum. — Los Angeles Co.: Monroavia.

Ribes parishi.—Los Angeles Co.: Monrovia.

Ribes roezli.—Alpine Co.: Centerville, Markleeville and Silver City, 1932. *Eldorado Co.*: Emerald Bay. *Mariposa Co.*: Chilnualna Falls, El Portal, Mariposa Grove, and Wawona. *Mono Co.*: Mono Lake. *Placer Co.*: Donner Lake, McKinney, and Tahoe City. *Sierra Co.*: Sierraville. *Siskiyou Co.*: Shasta City, 1934. *Tehama Co.*: Mineral. *Tuolumne Co.*: Aspen Valley, Carl Inn, Porcupine Flat, Tuolumne. *Yosemite National Park*: Alder Creek Ranger Station, Alder Creek, Eight Mile Point, Eleven Mile Point, Fort Monroe, Grouse Creek, Happy Isles near Yosemite, Inspiration Point, Mirror Lake, Snow Lake, Tioga Road 20 miles beyond Alder, and Yosemite.

Ribes speciosum. — Los Angeles Co.: Monrovia.

Ribes velutinum.—Alpine Co.: Centerville, East Branch Carson River, Markleeville, and New Woodford, 1932. *Mono Co.*: Bridgeport, Bridge Co. Farm, Chris Flat, Goat Ranch, Leevining Creek, Masonic, Mormon Meadow, Sweetwater Canyon, Toll House, West Walker River 12 miles north of Coleville, and Yancy Canyon.

COLORADO

Ribes aureum.—Denver Co.: Denver. *El Paso Co.*: Manitou. *La Plata Co.*: Bayfield. *Las Animas Co.*: Trinidad. *Mon-*

[2] Specimens for most of the collections reported are filed in the herbarium of the Plant Disease Survey, Division of Mycology and Disease Survey, Bureau of Plant Industry, Agricultural Research Administration, U. S. Department of Agriculture, in the University of Idaho Forest Pathology herbarium, and in the writer's herbarium.

tezuma Co.: Maneos.

Ribes odoratum.—Denver Co.: Denver. Scouting in 1920 revealed the rust on ribes in practically all parts of Colorado except in high mountains and on plains.

IDAHO

Ribes aureum.—Bear Lake Co.: Pegram. *Cassia Co.*: Burley. *Franklin Co.*: Preston. *Fremont Co.*: Chester. *Minidoka Co.*: Heyburn.

Ribes odoratum.—Franklin Co.: Preston. *Caribou Co.*: Soda Springs, 1936.

MONTANA

Ribes aureum.—Custer Co.: Calabar.

NEBRASKA

Ribes sp.—Kimball Co.: Kimball.

NEVADA

Pinus monophylla.—Mineral Co.: occasional on Sheep Creek and in Sweetwater Mountains; 7 per cent infection at Mountain House.

Ribes aureum.—Douglas Co.: Minden.

Ribes lasianthum.—Mineral Co.: Sheep Creek in Sweetwater Mountains.

Ribes montigenum.—Mineral Co.: Sheep Creek in Sweetwater Mountains.

Ribes velutinum.—Douglas Co.: 10 miles south of Minden. *Mineral Co.*: Carter's Station, Mountain House, and Sweetwater.

WYOMING

Seven locations of infection on unidentified species of ribes were found in the eastern part of the State from Acme, *Sheridan County,* near the Montana line, southward to Cheyenne and Pine Bluffs, *Laramie County,* in the southeastern part of the State.

The collections of the piñon blister rust on *Ribes lasianthum, R. hesperium, R. parishi, R. roezli, R. speciosum, R. cereum, R. indecorum, R. malvaceum, R. nevadense,* and *R. montigenum* are first reports for these species.

The collections on *Ribes inerme* in California, *R. aureum* in Montana and Nevada, and *R. odoratum* in Idaho are first collections of the rust in these States on these hosts. The presence of the rust in Montana and Nebraska has not been previously reported.

The reports made for southern Idaho and for Montana in the fall of 1922 are especially interesting because the collections were made by children during a school campaign conducted by the writer, in which the students were examining the leaves of ribes bushes in their vicinity for the presence of the white pine blister rust.

DISTANCE OF SPREAD

The published records together with the collections enumerated in this paper indicate a very wide geographical range of *Cronartium occidentale* on the wild ribes hosts, far beyond any locations of piñon pines found by any scouts or the known range as given by Munns (*1938*). Since the Western States were quite thoroughly scouted for piñon pines during the search for *C. occidentale,* and since no extension of the range of this pine was found beyond that reported by Munns (*1938*), his range for the piñon pines appears to be quite accurate. Likewise, published reports by Hedgcock, Bethel, and Hunt (*1918*) and by Garrett (*1919, 1921, 1937*), as well as the locations reported in this paper, have revealed a large, apparently contiguous area in which *C. occidentale* is found on piñon pines in southwestern Colorado, northern Arizona, the southern half of Utah, a smaller area on the east slope of the Sierra Nevada Mountains in Alpine and Mono Counties in California, and in the adjoining counties of Douglass and Mineral in Nevada.

The published records and the reports in this paper of locations where the piñon blister rust has been found on ribes at a considerable distance from piñon pines or from infected piñon pines indicate the probable distance of spread of aecispores from the piñon pines to ribes. This information is summarized in table 1. The distances (up to 425 miles) between locations of infected ribes and the nearest known piñon pines provide evidence of greater spread than had been previously expected. Since the even greater distances from known piñon pine infection may represent the actual distance of spread, the maximum distance might reach the entire 650 miles from Utah to Spokane, Wash. Although

it is well known that spores of fungi are distributed for long distances by air currents, these facts give a new conception of how rapidly a rust of this genus may extend over a wide area in the presence of only its uredial hosts.

TABLE 1

GREATEST KNOWN DISTANCE *CRONARTIUM OCCIDENTALE* AECIOSPORES HAVE SPREAD TO RIBES

Location of Ribes Infected with *C. occidentale*	Distance in Miles from Nearest Known		Year of Inspection
	Piñon Trees	Infected Piñon	
Monrovia, Calif.	40	140	1919-1921
Spokane, Wash.	425	650	1912, 1914
Calabar, Mont.	425	520	1922
Acme, Wyo.	350	425	1921
Kimball, Nebr.	75	125	1921
Rooks Co., Kans.	300	375	1892

This long-distance spread of the piñon blister rust suggests an explanation for the rapid spread of the white pine blister rust over the vast areas of white pine in the West from the original point of establishment of this rust at Vancouver, British Columbia, in 1910. Thus far the greatest spread of the aeciospores of *Cronartium ribicola* as reported by Mielke (*1943*) was 300 miles. However, the simultaneous appearance of the rust in 1923 at scattered points over the Idaho white pine area suggests a possible direct spread from Vancouver, British Columbia, a distance of approximately 400 miles. This distance of spread of the white pine blister rust now appears entirely possible in view of the known spread of the piñon blister rust. Indeed, the data for the piñon blister rust imply that the aeciospores of the caulicolous rusts may spread as far as 650 miles and infect the alternate host.

In the western part of the United States, the white pine blister rust has spread so rapidly from the north toward areas of known piñon blister rust infection that only 500 to 600 miles separate the sources of the aeciospores of these two rusts. Any Cronartium found on ribes leaves in this overlapping area requires careful study by means of one of the methods previously mentioned in order to determine which species is present. However, the presence of the rust on near-by white or piñon pines may be helpful in determining the species of Cronartium which is present. Also in many cases the amount of infection present on the ribes in the vicinity may give some indication as to whether or not the aecial source is in the immediate vicinity of the ribes. Mielke (*1943*) reports this relationship in the case of the white pine blister rust. Putnam[3] recorded an example of this association in the case of the piñon blister rust as a result of studies he made in August, 1921, on Desert Creek in the Sweetwater Mountains in California. From his report the data in table 2 were compiled.

TABLE 2

INCREASE OF *CRONARTIUM OCCIDENTALE* INFECTION ON RIBES AS DISTANCE FROM AECIAL SOURCE DECREASES

Distance from Aecial Source on Piñon Pine	Average Per Cent of Ribes Leaves Infected
1¼ mile	0.10
1 mile	0.10
¾ mile	0.50
½ mile	2.00
¼ mile	5.00
20 feet	50.00
Surrounded by aecia	90.00

It is apparent from these data that if the aecial source is near, the ribes will become more heavily infected the nearer the source is approached. On the other hand, if the infection is widespread and does not show a tendency to increase in any particular direction, the probability is that the aecial source is farther distant; and until the alternate host or hosts can be located it must be assumed that either or both rusts may be present.

OVERWINTERING

The intensity of either the piñon blister rust or the white pine blister rust on the ribes over a considerable area or even on a single bush, or the presence of either rust on the same bush annually, may suggest that the source of aecia is relatively close; but in exceptional cases this may not be true because of the ability of both rusts to overwinter occasionally on ribes under special climatic conditions. That overwintering of the piñon blister rust is a very infre-

[3] Putnam, H. N. Factors governing infection of ribes by *Cronartium occidentale*. Unpublished manuscript in files of the Office of the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine, Spokane, Wash., 1921.

quent phenomenon over the range of the rust as a whole is probable, since intensive scouting and observation for several years have revealed only a few cases. All these except one were found in southern California, indicating that overwintering may be a quite common phenomenon in that part of its range. However, it is not probable that the rust has spread for any great distance by means of wind dissemination of urediospores from ribes upon which it had overwintered, since the unrediospores are not well adapted to wind dissemination.

The first two cases found are reported in order to record the fact that this rust may overwinter on ribes. One instance of overwintering was found by Mr. Bethel and the writer at one of the parks in Denver, Colo., in March, 1922. Because of the frequent recurrence of the piñon blister rust on *Ribes aureum* in the parks at Denver, Colo., it had been suggested (Hedgcock *et al., 1918*) that probably the fungus was overwintering on the ribes. In this case a single *R. aureum* bush, well protected by other shrubs, had retained at the tips of the branches rosettes of leaves of the previous year. Some young leaves, about half normal size, had developed lower on the plant. Old uredia releasing urediospores were found on these old leaves and new uredia were found on the new leaves, indicating that the infection had spread from the old to the new leaves. The retention of the previous season's leaves by this bush was unusual because of the high altitude of Denver and the consequently severe winter weather.

The most abundant evidence of overwintering of *Cronartium occidentale* was found in southern California at Monrovia and Los Angeles. Here again it was observed that the rust was overwintering on the old leaves at the tips of the branches and was disseminating to the young leaves developing lower on the plants.

With reference to this case Mr. Bethel wrote[4] on February 21, 1920: "The rust was very abundant on old leaves (formed late last fall during the growing season) and in the form of blisters and old uredinial sori. After the rains and warmer weather the blisters break open (the rupture is irregular and not apical) and infect new leaves. The latter statement is based on observations made at Monrovia, when on February 8 most of the rust was in the blister form. The evidence at Monrovia is most convincing that the rust is carried over in the blister form. This habit is not peculiar to *C. occidentale* alone in this region but is to be seen in *Hyalopsora cheilanthis, Melampsora bigelowii,* etc."

On the bushes where the rust was overwintering a very few small telia were found. That the climatic conditions for the natural development and spread of the piñon blister rust were not favorable was indicated at the nursery at Monrovia, Calif., in which numerous trees of the piñon pine had been growing for several years within 50 yards of the heavily infected ribes without becoming infected. This lack of spread of the rust probably was due to unfavorable climatic conditions, but it also suggests the possibility that since the rust is continually reproducing itself by means of urediospores, a form of the rust devoid of telia or with telia of low visibility may be developing in southern California.

SUMMARY

1. Infection in nature with *Cronartium occidentale* of *Ribes lasianthum, R. hesperium, R. parishi, R. roezli, R. speciosum, R. cereum, R. indecorum, R. malvaceum, R. nevadense,* and *R. montigenum* is the first report for these species.
2. Collections on *Ribes inerme* in California, *R. aureum* in Montana and Nevada, and *R. odoratum* in Idaho are first reports of the rust on those hosts for these States.
3. The presence of *Cronartium occidentale* in Montana and Nebraska has not been previously reported.
4. The apparent spread of the aeciospores from piñon pines to ribes for a distance of 650 miles from known infected piñons and 425 miles beyond

[4] Letter to writer.

the known range of the piñon pine is reported.

5. *Cronartium occidentale* will overwinter on living ribes leaves.
6. Because of the similarity between the white pine and the piñon blister rusts these data suggest that a much longer distance of spread of the white pine blister rust is possible from pine to ribes than has been previously reported.

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TENTATIVE KEYS TO THE BOLETACEAE OF THE KANIKSU NATIONAL FOREST[1]

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EDITOR'S NOTE—These keys are reprinted from an article in the March 1944 issue of LLOYDIA entitled "Taxonomic-Ecologic Studies of the Boletaceae in Northern Idaho and Adjacent Washington." They are reprinted with the kind permission of the editor of LLOYDIA, with the thought that they would be of interest to northwestern collectors to whom that journal might not be available. The original article is the first publication in the senior author's study of the forest fungi in the arborvitae-hemlock zone in the Inland Empire. This project has been in progress since 1939 at the School of Forestry, University of Idaho. Field work has been centered on the Kaniksu National Forest where most of the forest land is occupied by typical arborvitae-hemlock zone associations. Here the climax forest comprises various mixtures of western arborvitae (western redcedar), western hemlock, and some grand fir, while the seral association includes western white pine, western larch, lodgepole pine, and considerable quantities of Douglas fir. Thus it may be seen that the forest economy of the region depends primarily upon timber species characterizing the aborvitae-hemlock zone. A better knowledge of the complex, fundamental relationships between the species comprising this zone is prerequisite to intelligent management for perpetual use of this great natural resource. Since the species of the Boletaceae collected in the course of the study are almost certainly fungal components of mycorrhizae produced on the tree species, the regional importance of this study may be appreciated.

A synopsis of the genera of the Boletaceae as proposed by Snell (Mycologia 33; 415-413: *ibid.* 34: 403-411) is presented before the keys as an aid in orientation of the family as it is treated in the LLOYDIA paper. Sixteen genera are included, only five of which are represented in collections made in the region to date. The taxonomic treatment departs radically from the currently accepted division of the family into four genera, *Boletinus, Boletus, Strobilomyces,* and *Gyrodon.* Synonyms cited for the species included are the names most widely used prior to combinations according to Snell's (*op. cit.*) proposals. Those interested in evaluating the present taxonomic treatment are referred to these two articles.

Two types of keys are employed in the LLOYDIA paper. The first is based on generic distinctions and is distributed throughout the text, key sections for each genus preceding descriptions of the species collected in this region. In this reprinting the first section of the generic key distinguishes the five genera collected to date, followed by sections treating each genus. The second key is based on gross characters, ignoring generic distinctions, and was developed primarily for field use with the twenty-three species found in the course of the study. Although perhaps more useful than the first key for field identification, the most serious criticism of such a key is that it may prove confusing if species are encountered which are not included in it. If such species possess certain characteristics in common with one or more of the species embraced by the key, erroneous identifications may result. It cannot be too strongly urged that all specimens identified with the aid of these keys be carefully compared with the species descriptions in the LLOYDIA paper or some authoritative taxonomic treatment of the Boltetaceae. If collections are run through both keys a good field check should be obtained. Characteristics found in collections made in the course of this study are emphasized in these keys, sometimes ignoring misleading characteristics reported from other regions. It should also be noted that the specimens on which the keys are based were described in detail while fresh; dried specimens in which colors are degraded and distortion due to shrinkage has occurred are extremely difficult for the amateur to identify. Several species appear more than once. This is an attempt to

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[1] ACKNOWLEDGMENTS—Sponsored by the Northwest Scientific Association and supported by grants-in-aid of $100 from that association and $675 from the Northwest Regional Council.

The senior author gratefully acknowledges the following additional aid in the conduct of the project: School of Forestry, University of Idaho—advice and encouragement from members of the faculty, and the unrestricted use of facilities; Northern Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service—advice and encouragement from personnel, the invaluable privilege of unrestricted use of facilities at the Priest River Experimental Forest as headquarters for field work since 1939; Kaniksu National Forest, U. S. Forest Service, and Western White Pine Region, Blister Rust Control, Division of Plant Disease Control, U. S. Bureau of Entomology and Plant Quarantine—many courtesies.

Special personal thanks are extended to the following individuals by the senior author: Dr. John Ehrlich, Associate Professor of Forestry, U. of Idaho, for his part in planning the project and his continuing interest and advice; Dr. Rexford F. Daubenmire, Assistant Professor of Botany, U. of Idaho, for aid in ecological phases; Mr. and Mrs. Vincent L. Benton, of Pawtucket, R. I., and Mr. Robert F. Patton, of Long Beach, Cal., for assistance in field work during 1940; and Mrs. A. W. Slipp, wife of the senior author, for invaluable and continuing assistance since inception of the project.

include all important variations in gross characters which have appeared in the collections, in order to minimize error in identification.

Although these keys are compiled from collections made almost exclusively on the Kaniksu National Forest they should be widely useful throughout the Inland Empire from the Cascades east to the continental divide both north and south as far as arborvitae-hemlock zone associations occur in the region. Roughly the southerly limits of the zone in Washington meet the Douglas fir zone at the southern edge of the Okanogan Highlands. Both the ponderosa pine and Douglas fir zones separate the arborvitae-hemlock zone from the unforested basal plain, forming a belt varying from 60 miles in width in Okanogan and Ferry counties to less than half a mile along the eastern margin of the Palouse in Idaho. The climax species, and western white pine, do not occur south of the Salmon National Forest in Idaho, the great body of the zone lying north of the Clearwater River. These species extend northward into British Columbia along the lower and middle slopes of the Selkirks and the Rockies, western arborvitae reaching 400 miles north of the international boundary. Western white pine is found 200 miles north of the border while western hemlock extends only 125 miles into Canada. Thus, the inland extension of the arborvitae-hemlock zone occurs for 650 miles north and south along the lower and middle slopes of the Rockies, and subsidiary ranges, and there is reasonable expectation that the species covered by these keys occur throughout this region in arborvitae-hemlock zone associations. Undoubtedly other species will be found in other parts of this extensive area. The authors will be grateful for collections made anywhere within it, particularly species not before encountered. Collectors contributing specimens will aid the project if they will list all tree species occurring within 100 feet of the collections, or at least note the general timber type, and carefully record geographic location.

BOLETACEAE—SYNOPSIS

Fleshy hymenomycetous fungi, stipate, the hymenium lining tubes beneath a thick, usually convex, pileus. Annual, terrestrial, or very rarely lignicolous.

Subfamily BOLETEAE—Spores smooth.

Tribe EUBOLETEAE—Spores long-elliptical or subfusiform, colored: hymenophore tubulate, boletinoid, or even lamellate; tubes compound or simple.

Genus BOLETINUS—Tubes arranged radially in rows, usually with more or less prominent veins between (boletinoid), at least when young; not easly separable from the carpophore and not at all from each other.

Genus SUILLUS—Stipe not reticulate, except at the very apex or above annulus in a few forms; tubes adnate or decurrent, not free and not stuffed when young; pileus viscid when wet or at all times; spores elliptical.

Genus XEROCOMOS—Pileus dry, never viscid, may be glabrous, subpruinose, or subtomentose; tubes simple or compound, never stuffed or with red mouths; spores subfusiform; stipe never truly reticulate or subbulbous.

Genus BOLETUS—Fruiting body rather stout and robust; tubes simple; stipe stout and more or less bulbous, especially at first; spores subfusiform.

Section CALOPODES—Stipe reticulate; tubes adnate, not stuffed when young.

Section EDULES—Tubes free, or if adnate then stuffed when young.

Section LURIDI—Tube mouths some shade of red. None collected in the region.

Genus LECCINUM—Tubes white, at least at first, free or adnate, stuffed when young if the latter; stipe more or less slender and scabrous, tapering upward; spores more or less fusiform-elliptical.

The following genera were not collected in the course of this study.

Genus PHYLLOPORUS—Tubes lamellate, anastomosing; spores subfusiform.

Genus PULVEROBOLETUS—Pileus and stipe more or less pulverulent; tubes simple; spores small, ellipsoid to ovoid.

Genus TYLOPILUS—Tubes and spores flesh-colored.

Genus PORPHYRELLUS—Pileus pilose; spores reddish.

Tribe GYRODONTEAE—Spores small and oblong to short-elliptical or nearly subglobose, colored; hymenophore more or less boletinoid and more or less lamellate; tubes short to very short.

Genus BOLETINELLUS—Hymenophore very lamellate, merulioid; spores very broadly elliptical, thick-walled. One species only, *B. merulioides* (*B. porosus*).

Genus GYRODON—Spores very small, short-ellipsoid.

Tribe LEUCOSPORELLEAE—Spores oblong or short-elliptical to narrowly ellipsoid,

hyaline, white (?) or yellow in mass; carpophore imputrescible; tubes simple, at first white, then usually yellow; stipe hollow or solid.

Genus GYROPORUS—Stipe not reticulate, spongy within, soon hollow; pileus dry; spores oblong or short-elliptical, about twice longer than broad.

Genus LEUCOGYROPORUS—Stipe glabrous, solid; pileus dry, glabrous, felted, or subtomentose; spores narrowly-ellipsoid to more or less cylindric or subfusiform, 3 to 4 times longer than broad.

Subfamily STROBILOMYCETEAE—Spores ornamented, reticulate, striate, or verrucose.

Genus STROBILOMYCES—Spores reticulate, globose; pileus squarrose-scaly; tubes not boletinoid; separable from the carpophore with difficulty and not all from each other.

Genus BOLETELLUS—Spores longitudinally striate or wrinkled, or verrucose, elliptical, large.

Genus POLYPOROLETUS—Spores verrucose, spherical.

GENERIC KEY

(Includes only those genera of the Boletaceae collected.)

A. Tubes boletinoid (except sometimes in *Boletinus amabilis*) ..... I. BOLETINUS

B. Tubes not boletinoid.

1. Stipe not reticulate, except at very apex or above annulus in a few forms; not scabrous.
   a. Pileus viscid when wet, or at all times, at least in some degree; tubes adnate or decurrent, not free, and not stuffed when young; spores elliptical....II. SUILLUS
   b. Pileus dry, never viscid; glabrous, subpruinose or subtomentose; tubes simple or compound; spores subfusiform.....III.XEROCOMUS
2. Stipe truly reticulate from apex to below center, excluding those reticulate only at apex above an annulus; or if not, then tube mouths red, or tubes stuffed when young ..... IV. BOLETUS
3. Stipe scabrous, or at least squamulose, tapering; tubes white, at least at first, not stuffed when young; spores more or less broadly fusiform-elliptical..... V. LECCINUM

I. BOLETINUS Kalchbrenner

1. Stipe annulate, even when mature 2
   Stipe exannulate, at least at maturity 3
2. Stipe hollow ..... 1[2] *Bol. cavipes* (*Opatowski*) *Kalchbrenner*
   Stipe solid; tubes in many specimens *not* boletinoid.....2. *Bol. amabilis* (Peck) Snell. (*Boletus amabilis* Peck).
3. Pileus some shade of red or pink, usually with yellowish cast, fibrillose-scaly ..... 3. *Bol. ochraceoroseus* Snell
   Pileus light brownish yellow, glabrous to faintly fibrillose.....4. *Bol. appendiculatus* Peck

II. SUILLUS Micheli ex S. F. Gray

1. Color of flesh of pileus or stipe, or both, changes to blue when cut or broken 2
   Color of flesh of pileus or stipe not changing to blue, although a change to brown may occur in some species 4
2. Pileus yellow or orange, with or without streaks or patches of red brown or vermilion 3
   Pileus gray or gray brown, soft; tubes sand brown or brownish gray.....6. *S. aeruginascens* (Secretan) Snell.(*Boletus viscidus* L. ex. Fries).
3. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, very rarely changing to blue at base of stipe when cut or broken, densely glandular-dotted, glandules greenish-brown or rarely same color as stipe, frequently confluent; pileus may be streaked red brown or vermilion, stains hands yellow with sticky-viscid gluten.....12. *S. americanus* (Peck) Snell. (*Boletus americanus* Peck).
   Stipe neither slender nor particularly tough, never hollow, glandular-dotted, the glandules small, brown but not greenish-brown; pileus without reddish markings, color bright yellow or orange, does not stain hands yellow; flesh changes to clear blue when cut or broken .....

[2] Numbers preceding species names indicate order of the descriptions in the LLOYDIA paper.

.....5. *S. hirtellus* (Peck) Snell var. *mutans* Peck *apud* Snell. (*Boletus hirtellus* Peck var. *mutans* Peck *apud* Snell).

4. Stipe not glandular-dotted 5
   Stipe glandular-dotted 6
5. Pileus gray or gray brown, glabrous, soft; tubes sand brown to brownish gray, usually changing to blue where bruised, but some specimens show no change .....6. *S. aeruginascens* (Secretan) Snell (*Boletus viscidus* L. ex Fries).
   Pileus shiny golden brown or chestnut; tubes bright golden yellow..... .....7. *S. elegans* (Fries) Snell. (*Boletus elegans* Fries, and *B. Clintonianus* Peck).
6. Annulus present, at least in a few specimens 7
   Annulus not present at any stage of development..... 9
7. Margin of pileus never tomentose at any stage of development 8
   Margin of pileus tomentose when immature, usually loosely and densely so, the tomentum disappearing before pileus is fully expanded, color yellow, with or without red brown or vermilion streaks or patches, stains hands yellow from sticky-viscid gluten; stipe unusually slender and tough, densely glandular-dotted, glandules greenish-brown or rarely same color as stipe, conspicuous, frequently confluent.....12. *S. americanus* (Peck) Snell. (*Boletus americanus* Peck).
8. Veil not sheathing the whole stipe, entirely superior; annulus usually wide, appressed-cylindric, of same color and texture as pileus, fibrillose-virgate, viscid when wet; pileus broadly subconic to convex, typically the former; stipe densely glandular-dotted, glandules confluent into large greenish-brown patches toward base.....10. *S. subluteus* (Peck) Snell. (*Boletus subluteus* Peck).
   Veil sheathing the stipe; annulus usually flaring upward, not appressed-cylindric, viscid when wet, often disappearing at maturity; pileus relatively thick, rounded-pulvinate approaching hemispherical; stipe glandular-dotted, especially above the annulus.....11. *S. luteus* (L. ex Fries) S. F. Gray. (*Boletus luteus* L. ex Fries).
9. Margin of pileus tomentose when young 10
   Margin of pileus never tomentose, rarely fibrillose-appendiculate; flesh of pileus pure white when young, later pale yellow near tubes and white above; stipe finely glandular-dotted usually less than half the length ....9. *S. granulatus* (L. ex Fries) Snell. (*Boletus granulatus* L. ex Fries.)
10. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish-brown or rarely same color as stipe, frequently confluent; pileus yellow, may be streaked red brown or vermilion, stains hands yellow with sticky-viscid gluten.....12. *S. americanus* (Peck) Snell. (*Boletus americanus* Peck).
    Stipe stout, solid, closely glandular-dotted, glandules brown; pileus dull yellow to buffish yellow, duller than *S. americanus*, rarely may be red brown or vermilion streaked, readily confused with *S. americanus* and *S. granulatus*..... .....8. *S. subaureus* (Peck) Snell. (*Boletus subaureus* Peck).

III. Xerocomus Quélet

1. Stipe some shade of red, at least in part 2
   Stipe yellow or brown, not red 5
2. Tube surface not turning blue where bruised, its color bright lemon to olivaceous yellow; pileus dark greenish brown; stipe deep crimson to brownish red..... .....13. *X. Zelleri* (Murrill) Snell. (*Boletus Zelleri* Murrill, or *Ceriomyces Zelleri* Murrill).
   Tube surface turning blue where bruised 3
3. Stipe uniformly red at base, yellow at apex; pileus khaki, rimose-areolate..... .....16. *X.* sp. (A probable new species, not named because of inadequate collections.)
   Stipe not uniformly red at base, at most red only in limited areas, or uniformly pinkish brown 4
4. Pileus rose beneath a yellowish bloom which may be rubbed off, not rimose; stipe yellow with red areas; tube surface ochre yellow.....17 *X.* sp. (A probable new species, not named because of inadequate collections.)
   Pileus warm brownish khaki to dull brown with mustard-colored bloom, subtomentose, not rimose, or rarely deeply rimose-diffract, at least in part; stipe

pinkish brown or with a mustard cast; tube mouths large (to 3 mm.), angular, in mature specimens; may or may not change to blue when cut or broken, but never suddenly or deeply; a large species.....14. *X. subtomentosus* (L. ex Fries) Quélet. (*Boletus subtomentosus* L. ex Fries).

5. Stipe, tubes, and flesh bright lemon yellow, changing immediately to deep blue where cut or bruised; pileus olivaceous khaki, rimose-areolate to rimose-diffract. .....15. *X.* (?) *pulverulentus* (Opatowski) Gilbert. (*Boletus pulverulentus* Opatowski).

   Stipe brown, or pinkish brown, with mustard cast; pileus warm brownish khaki to dull brown with mustard-colored bloom, subtomentose, not rimose, or rarely deeply rimose-diffract, at least in part; tube mouths large (to 3 mm.), angular, in mature specimens; may or may not change to blue when cut or broken, but never suddenly or deeply; a large species ..... 14. *X. subtomentosus* (L. ex Fries) Quélet. (*Boletus subtomentosus* L. ex Fries).

IV. Boletus Dillenius ex Fries

1. Tubes and mouths of the same color 2

   Tubes and mouths differently colored, mouths some shade of red..... .....Section Luridi. None collected in the region.

2. Tubes free or adnate; if the latter then stuffed when young..... .....Section Edules 3

   Tubes adnate, not stuffed when young ....Section Calopodes 4

3. Tubes white at first, then greenish yellow; pileus khaki, glabrous; stipe light yellow brown; color of flesh unchanging .... 18. *B. edulis* Bulliard ex Fries.

   Tubes lemon yellow to greenish yellow; pileus brown, slightly olivaceous, subtomentose; stipe lemon yellow, turning brown where bruised; color of flesh changing to blue where cut or broken, taste bitter.....19. *B. fragrans* Vittadini.

4. Pileus dark chocolate brown, tomentose to fibrillose-scaly; stipe brownish red to dark crimson, bulbous.....20. *B. mirabilis* Murrill. (*Ceriomyces mirabilis* Murrill).

   Pileus buff to sand brown, closely canescent, deeply rimose-diffract forming subpyramidal frusta, at least in part; tubes very short, mouths very small; a large species .....21. *B. frustosus* Snell and Dick.

V. Leccinum S. F. Gray

1. Color of stipe surface changing to blue where bruised, at least at base; pileus yellowish orange, orange yellow, or somewhat reddish brown, glabrous, viscid .....22. *L. versipelle* (Fries *apud* Hök) Snell. (*Boletus versipellis* Fries *apud* Hök).

   Color of stipe surface unchanging where bruised, or at least not changing to blue; pileus variable, warm brownish chamois to dull walnut brown, or grayish brown, glabrous, dry.....23. *L. scabrum* (Bulliard ex Fries) S. F. Gray. (*Boletus scaber* Bulliard ex Fries).

GROSS CHARACTER KEY

An artificial key to species employing gross characters, omitting generic distinctions.

1. Color of flesh of pileus or stipe, or both, changing to blue when cut or broken.... 2

   Color of flesh of pileus or stipe, or both, changing to some other color when cut or broken, or not changing 12

2. Margin of pileus tomentose when young, usually loosely and densely so, the tomentum disappearing before pileus is half expanded, color yellow, with or without red brown or vermilion streaks or patches, stains hands yellow from sticky-viscid gluten; stipe unusually slender and tough, almost always hollow at base in this region, densely glandular-dotted, the glanadules greenish brown or rarely same color as stipe, conspicuous, frequently confluent..... .....12. *Suillus americanus* (Peck) Snell. (*Boletus americanus* Peck).

   Margin of pileus never tomentose 3

3. Pileus some shade of bright yellow or orange, glabrous or fibrillose-scaly; tube surface dull or dirty yellow, changing to blue on injury; stipe various shades of yellow, masked by glandular-dots which are pale when young, brown when mature, annulus none ..... 5. *Suillus hirtellus* (Peck) Snell var. *mutans* Peck *apud* Snell. (*Boletus hirtellus* Peck var. *mutans* Peck *apud* Snell).

   Pileus some shade of gray, olive, brown, or rose, not yellow or orange..... 4

4. Stipe dirty white, scabrous to squamulose, changes to greenish blue where bruised; pileus slightly reddish brown, dull orange, or yellowish orange, glabrous, viscid; tube surface dirty white ..... 22. *Leccinum versipelle* (Fries *apud* Hök) Snell. (*Boletus versipellis* Fries *apud* Hök.)

   Stipe neither white nor squamulose-scabrous 5

5. Pileus viscid, particularly in wet weather, gray brown to gray, sometimes with irregular patches of red brown or blue, or both; tube surface sand brown to brownish gray, usually changing to blue where bruised; stipe dirty gray-white to faintly brownish gray, rarely the former, reticulate at apex, rarely almost to middle of stipe, annulus small, usually disappearing ....6. *Suillus aeruginascens* (Secretan) Snell. (*Boletus viscidus* L. ex. Fries).

   Pileus not viscid, at most somewhat moist 6

6. Flesh of pileus with bitter taste, pileus olive brown; stipe lemon yellow, conspicuously reticulate almost to base in our collection but usually regarded as not reticulate or only slightly so.....19. *Boletus fragrans* Vittadini.

   Flesh of pileus without bitter taste, although some may be unpleasant 7

7. Stipe some shade of red, at least in part 8

   Stipe yellow or brown, not red 11

8. Tube surface not turning blue where bruised, its color bright lemon to olivaceous yellow; pileus dark greenish brown; stipe deep crimson to brownish red; flesh of stipe and pileus changing to blue slowly, usually from 10 to 30 minutes following cutting; apparently occurring only in western arborvitae-western hemlock associations.....13. *Xerocomus Zelleri* (Murrill) Snell. (*Boletus Zelleri* Murrill, or *Ceriomyces Zelleri* Murrill).

   Tube surface turning blue where bruised 9

9. Stipe uniformly red at base, yellow at apex; pileus olivaceous khaki, rimose-areolate over whole surface, the cracks sometimes reddish.....16. *Xerocomus* sp. (A probable new species, not named because of inadequate collections.)

   Stipe not uniformly red at base, at most red only in limited areas, or uniformly pinkish brown 10

10. Pileus rose beneath a yellowish bloom which may be rubbed off, not rimose; stipe yellow with red areas; tube surface ochre yellow.....17. *Xerocomus* sp. (A probable new species, not named because of inadequate collections.)

    Pileus warm brownish khaki to dull brown, with mustard colored bloom, subtomentose, not rimose, or rarely rimose-areolate to rimose-diffract at least in part; stipe pinkish brown, or with a mustard cast; tube mouths large (to 3 mm.), angular, in mature specimens; a large species. .....14. *Xerocomus subtomentosus* (L. ex Fries) Quélet. (*Boletus subtomentosus* L. ex Fries).

11. Stipe, tubes, and flesh bright lemon yellow, changing immediately to deep blue where cut or bruised; pileus olivaceous khaki, rimose-areolate to rimose-diffract .....15. *Xerocomus* (?) *pulverulentus* (Opatowski) Gilbert. (*Boletus pulverulentus* Opatowski).

    Stipe brown, or pinkish brown, with mustard cast; pileus warm brownish khaki to dull brown with mustard colored bloom, subtomentose, not rimose, or rarely rimose-areolate to rimose-diffract at least in part; tube mouths large (to 3 mm.), angular, in mature specimens; a large species.....14. *Xerocomus subtomentosus* (L. ex Fries) Quélet. (*Boletus subtomentosus* L. ex Fries).

12. Tubes boletinoid in all specimens 13

    Tubes not boletinoid, or at least not so in all specimens 15

13. Stipe hollow, yellow from decurrent tube surface above annulus, brown below; pileus mahogany or chocolate brown, or rarely golden yellow, fibrillose-scaly; common in western larch-western white pine associations ....1. *Boletinus cavipes* (Opatowski) Kalchbrenner

    Stipe solid 14

14. Pileus some shade of red or pink, with yellowish cast present in varying degree, coarsely fibrillose-scaly; tube surface mustard to dull olivaceous yellow, decurrent on stipe forming reticulation almost to base; common in western larch-western white pine associations.....3. *Boletinus ochraceoroseus* Snell.

    Pileus light brownish yellow, glabrous to faintly fibrillose, stipe dull yellow, no annulus .....4. *Boletinus appendiculatus* Peck.

15. Pileus deeply cracked to form subpyramidal frusta, buff to sand brown, closely canescent; tubes short, mouths extremely small, being rarely larger than 0.15

mm.; stipe buff to sand brown, reticulation on top half only.....21. *Boletus frustosus* Snell and Dick.

Pileus not deeply cracked 16

16. Stipe brownish red to dull crimson, bulbous to subbulbous, tapering strongly upward, reticulate near apex; pileus dark chocolate brown, tomentose to fibrillose-scaly, the scales often in the form of conic points or projections about the center; tube surface bright lemon yellow to dull mustard yellow; common only in western arborvitae-western hemlock associations ..... 20. *Boletus mirabilis* Murrill. (*Ceriomyces mirabilis* Murrill).

Stipe some shade of white, gray, yellow, or brown, not red 17

17. Stipe reticulate almost full length, light yellowish brown, no annulus; pileus khaki, glabrous; tube surface white at first, then greenish white.....18. *Boletus edulis* Bulliard ex Fries.

Stipe not reticulate almost full length, although some may be reticulate near apex 18

18. Stipe scabrous, rough, dirty white with projections gray or brown; pileus glabrous, color variable in shades of brown; tube surface dull white to fawn .....23. *Leccinum scabrum* (Bulliard ex Fries) S. F. Gray. (*Boletus scaber* Bulliard ex Fries).

Stipe not scabrous 19

19. Stipe hollow at maturity, unusually slender and tough, densely glandular-dotted, the glandules greenish brown or rarely same color as stipe, conspicuous, frequently confluent; pileus golden to mustard yellow, with or without brownish red or vermilion patches or streaks; flesh of stipe and pileus changing to faintly roseate when cut, or very rarely to faint blue at base of stipe only .....12. *Suillus americanus* (Peck) Snell. (*Boletus americanus* Peck).

Stipe not hollow 20

20. Annulus usually appressed-cylindric, wide, persistent, of the same color and surface texture as the pileus, varying from bronze through olive drab to a dirty buckskin yellow; stipe yellow at apex, white to base, masked by the dense greenish brown glandular-dots which are frequently confluent into patches toward base; pileus glabrous, but appearing conspicuously fibrillose (fibrillose-virgate), viscid only when wet; tube surface lemon to dull mustard yellow, the mouths flecked with brownish glandules..... .....10. *Suillus subluteus* (Peck) Snell. (*Boletus subluteus* Peck).

Annulus none, or if present not appressed-cylindric 21

21. Annulus none at any stage of development 22

Annulus present at least when immature 24

22. Margin of pileus never tomentose, rarely fibrillose-appendiculate; flesh of pileus pure white when young, later pale yellow near tubes and white above; stipe finely glandular-dotted usually less than half the length.....9. *Suillus granulatus* (L. ex Fries) Snell. (*Boletus granulatus* L. ex Fries).

Margin of pileus tomentose when young, before halfway expanded 23

23. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish brown or rarely same color as stipe, frequently confluent, conspicuous; pileus yellow, with or without red brown or vermilion streaks or patches, stains hands yellow with sticky-viscid gluten ....12. *Suillus americanus* (Peck) Snell. (*Boletus americanus* Peck).

Stipe stout, solid, closely glandular-dotted, glandules brown; pileus dull yellow to buffish yellow, duller than *Suillus americanus*, may rarely be marked with red brown or vermilion streaks or patches; readily confused with *S. americanus* or *S. granulatus*.....8. *Suillus subaureus* (Peck) Snell. (*Boletus subaureus* Peck).

24. Pileus gray or gray brown, viscid, particularly in wet weather; stipe dirty white to faintly brownish gray, may change to blue where bruised; flesh of stipe and pileus also commonly changes to blue where cut or broken, but some specimens show no change, these chiefly immature; flesh soft, frequently watery .....6. *Suillus aeruginascens* (Secretan) Snell. (*Boletus viscidus* L. ex. Fries.)

Pileus yellow to brown, not gray or gray brown..... 25

25. Pileus dry, not viscid, coarsely fibrillose to fibrillose-scaly, cocoa brown, stipe yellow from decurrent tube surface to annulus, brown like the pileus below; common only in association with Douglas fir in this region ....2. *Boletinus amabilis* (Peck) Snell. (*Boletus amabilis* Peck).

Pileus not dry, usually viscid 26

26. Stipe not glandular-dotted, usually brown-fibrillose over golden yellow; annulus prominent, persistent, but not flat and wide; pileus bright, shiny golden brown or chestnut, viscid; tube surface bright yellow; common in western larch-western white pine associations .....7. *Suillus elegans* (Fries) Snell. (*Boletus elegans* Fries, and *B. Clintonianus* Peck).

Stipe glandular-dotted 27

27. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish brown or rarely same color as stipe; annulus absent in approximately half specimens collected, but when present tomentose, not flaring, usually fragmentary; pileus yellow, with or without red brown or vermilion streaks or patches, stains hands yellow with sticky-viscid gluten .....
.....12. *Suillus americanus* (Peck) Snell. (*Boletus americanus* Peck).

Stipe stout, not particularly tough, glandular-dotted, especially above the annulus; annulus prominent, glutinous, flaring upward at least when young and usually to maturity; pileus dark buckskin or yellowish brown to reddish brown, thickly sticky-viscid .....
.....11. *Suillus luteus* (L. ex Fries) S. F. Gray. (*Boletus luteus* L. ex Fries).

THE COUNTIES OF WASHINGTON: A REVIEW

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The Counties of Washington. Published by Belle Reeves, Secretary of State, Olympia, Washington, 1943.

The Counties of Washington is a substantial volume, 8½ x 10½ inches in size, with an attractive cover of pictures illustrating industries of Washington. The publication is carefully printed by a multigraph system and the type is attractive and legible. The book was prepared by Richard M. Petty, supervisor of the Bureau of Statistics.

There are 39 counties in the state and of these 17 are named after men, 16 bear names of Indian origin, 5 are descriptive of geographic features (Columbia, Grays Harbor, Island, Pacific, and San Juan) and one (Pend Orielle) is of French derivation and was first applied to an Indian tribe. The counties are discussed in alphabetical order. For each the origin of the county name is given, followed by descriptions of the area, farm statistics, topography, population, transportation, special industries, minerals, cities, etc. At the close of the book several pages are devoted to farm statistics, the data for which were secured in 1942. The population of Washington is now estimated at 2,003,-980, a gain of 15.4% since the 1940 census. There is a table of estimates for the population of all Washington towns and cities that are thought to have gained 3% or more in population since the census of 1940. For example Seattle is supposed now to have 480,000 inhabitants, Spokane 142,000, Tacoma 140,000, Bremerton 48,000, Everett 35,000 and Vancouver 30,000. Small towns in eastern Washington that show a high rate of increase include Ephrata, Kennewick, Moses Lake, Pasco, and Soap Lake.

The publication will be found very useful by teachers and others interested in securing the latest authentic information on the counties, industries, and state as a whole. Part of the duties of the Secretary of State is to publish and disseminate information about Washington and the reviewer of this book believes it admirably adapted to this purpose and highly compliments Miss Reeves and Mr. Petty on the publication.

IN MEMORIAM

J. R. BENDER

Jacob Roy Bender was born at Uhrichsville, Ohio, Oct. 13, 1892, and died at Moscow, Idaho, March 14, 1943.

After the work of grade school and of high school, Mr. Bender entered Ohio University at Athens, Ohio, graduating with major work in mathematics and physics. For graduate work he went to the University of Washington, where he held a fellowship in mathematics, and obtained the Master's Degree.

After leaving the University of Washington, Mr. Bender taught in high school and at Bradley Polytechnical Institute. In September 1921 he joined the Faculty of the University of Idaho as Assistant Professor of Mathematics. He remained at Idaho until his death, at which time he held the rank of Associate Professor.

Although actively interested in research work, particularly in the field of mathematical statistics, Professor Bender's life was preeminently that of a teacher. To this work he brought ability, patience and understanding. He was well liked by students and by his colleagues, and he has been greatly missed in the department and on the campus.—EUGENE TAYLOR.

Dr. John B. Appleton, Director of the Northwest Regional Council, Portland, and Vice-President of the Northwest Scientific Association, has accepted a position as Assistant Chief of the Far Eastern Division, Office of Strategic Services, Washington, D. C. The appointment is for the duration of the war.

Dr. Appleton's training and experience as a geographer fits him particularly for this important war post. His academic training was received at the London School of Economics, the University of Besancon, France, and the University of Chicago. He taught geography for several years at the University of Illinois, and at Scripps and Claremont Colleges. He has traveled extensively in France, Palestine, Arabia, and Egypt, as well as in China, Manchukuo, and Japan. His study of Far Eastern problems during the fifteen months he spent there gave him a background especially valuable in his present work. During the last war, he was an officer in Britain's Royal Air Force.

Dr. Appleton has been with the Northwest Regional Council since its formation in 1938. His direction of the Council in its efforts to disseminate information on Northwest problems, and to stimulate and encourage further Northwest research, has been a real contribution to the region.—STEPHEN N. WYCKOFF.

WARTIME ACTIVITIES AND PROGRAMS IN NORTHWEST EDUCATIONAL INSTITUTIONS

The following brief outline of wartime activities in educational institutions of the Northwest presents but a glimpse of the tremendous effort in the education of scientifically trained armed services personnel which engages virtually all such schools today. This region may justly be proud of the record so briefly indicated in these items. It has been impossible to include in this issue similar news from several other institutions, due to space limitations. This material, and notes concerning wartime activities of faculty members on leave of absence, will be held for the next issue.

UNIVERSITY OF OREGON

Special Wartime Services and Programs

During the present academic year, the University of Oregon's war service has centered in its Army technical training programs. A unit of the Army Air Forces Premeteorology program "C" was organized on the campus in the spring of 1943. In the summer of 1943 the University was assigned a unit of the Army Specialized Training Program, General Basic curriculum B-1. In the fall the A. S. T. P. was enlarged to include advanced Foreign Area and Language studies (Curriculum 71), with classes in Spanish, Portuguese, Norwegian, Italian, and Russian. A Premedical program (Premedical) was added in March 1944.

At the University of Oregon Medical School in Portland both Army and Navy medical training programs are in operation, as well as an accelerated program for the training of nurses.

The soldiers assigned to the University for the General Basic curriculum and Foreign Area and Language were transferred to active duty in March 1944. The Premedical and Premeteorological programs are continuing.

The A. S. T. P. General Basic curriculum, the Army Air Forces Premeteorology curriculum, and the Premedical curriculum have involved very heavy burdens of instruction for the science faculties of the University. A considerable number of special instructors have been employed, especially in mathematics and physics, but regular faculty members have had to carry large class loads to maintain the Army programs and at the same time satisfy the science needs of regular civilian students.

Apart from regular R. O. T. C. training, the first program organized looking toward wartime needs was in civilian pilot training, under the auspices of the Civil Aeronautics Authority, in the fall of 1939. During 1942-43 nearly all physically fit male students were enrolled in one or another of the Army and Navy enlisted reserves.

Wartime Activities of Science Faculty Members

The principal war service of members of the science faculties who have remained on the campus has been science instruction in the several Army programs mentioned above. A number of individuals have, however, taken a leading part in civilian defense activities and in other programs related to the war.

Dr. Will V. Norris, acting head of the Department of Physics, is academic director of all Army training programs on the campus, and serves as an educational consultant for the Ninth Service Command of the U. S. Army.

Dr. L. S. Cressman, head of the Department of Anthropology, was for two years chief observer in charge of an Army aircraft warning station located on the campus.

Dr. D. S. Dedrick, Assistant Professor of Chemistry, has served as an instructor in gas and bomb warfare for the Lane County Civilian Defense Council.

OREGON STATE COLLEGE

Special Wartime Services and Programs

Oregon State College began an Army Specialized Training Program in March 1943. Three fields have been covered: Advanced Engineering, Basic Engineering, and a Foreign Area and Language curriculum. While the exact number taking part in these programs cannot be disclosed, the engineering contingent has been a large one.

The Foreign Area and Language work was begun in July 1943 and was increased in October. Five languages are included in the program: Russian, Chinese, Spanish, German, and French. The faculties provided for these programs have been outstanding and remarkable success has been achieved in meeting the Army's demands for specialists in these fields.

The College is now engaged in building special curricula to provide for the rehabilitation of men now being discharged from the armed forces and also to meet the demands of those returning at the conclusion of the war. Special curricula, running from one to four years have been outlined in fields which are expected to be of interest to those leaving military service. Reports of

services and programs of the various science departments follow.

Bacteriology Department — The department is working actively with the health officers at Camp Adair and the airbase on water supply and sewage disposal. The water supply for Camp Adair has been used as a practical laboratory for advanced students in bacteriology and sanitation. The milk supply of this area has also been carefully studied by the department. Prof. G. V. Copson, Dr. J. S. Simmons, and Dr. W. B. Bollen have been active.

Botany Department and Agricultural Experiment Station—Enrollment in the Botany Department has dropped to a very low figure. Some staff members have transferred part-time to other departments such as Physics and Geology (Geography) where the war emphasis has caused large increases in enrollment. Other members have gone on leave-of-absence for the year to carry on special research work.

Despite the bearing which research on the control of plant diseases has upon the war effort, all assistants have entered the armed forces, thus leaving the older members of the staff to carry on without assistance. In spite of this, the Station staff has concentrated its efforts almost entirely upon diseases of food crops and has taken on additional problems dealing with the control of diseases of vegetables and fruits.

Zoology Department — The Department of Zoology is giving fundamental training to students enrolled in Pre-nursing, Predental, Laboratory Technology and Premedical curricula.

Members of the department have been called on by medical officers at Camp Adair to acquaint them with amphibians, snakes and rodents, particularly those of a harmful nature found in the area surrounding the camp. Many of these medical officers have come to various members of the Department, particularly Dr. E. J. Dornfeld, for help with microtechnique problems related to the preparation of tissues for microscopic examinations. Also charts and models have been loaned the medical staff to be utilized for lectures and demonstrations to the enlisted personnel.

Entomology Department—The department is engaged in the protection and conservation of food, fiber, seed, and forage crops by means of study and control of insect pests, teaching Medical Entomology to Army Medical Officers, and cooperation with the Surgeon General's office and the State Health office in malaria mosquito control.

Geology Department — Many industries in and about Portland produce the chemical and metallurgical necessities which keep the shipyards, aluminum plants, and airplane factories alive. These essential industries depend largely upon minerals of peculiar composition and properties. All last summer, Dr. Hodge searched for some of these minerals and is in almost daily consultation respecting them. At times, conditions were so serious that deep concern was felt over possible shortages. Fortunately Dr. Hodge, because of his long experience and intimate knowledge of the mineral occurrences of the Northwest, was able to direct investigations leading to discovery of satisfactory supplies.

Chemistry Department — Due to the close proximity of Camp Adair, the Chemistry Department has been able to render many small services in the way of consultation and advice to chemical warfare officers, the personnel of water purification laboratories, the Services of Supply and the Service Command Unit.

A most interesting experience was had in connection with 32 graduate chemists assigned to the college for one term of training last summer under the 9A Army Specialized Training Program. As attempted in this instance the program was, so far as can be determined, different from that followed in any other institution and consisted of a series of short courses in chemical toxicology, water analysis, advanced organic synthesis, as well as a review in fundamental physical and organic chemistry. Students who came with specialized background, such as biochemistry, were offered opportunity for specialized advanced work in their respective fields

with the result that several commissions were obtained. A large proportion of these men were subsequently assigned to fields where this training was highly advantageous.

Physics Department—In common with all departments on the campus, the Department of Physics has been teaching the A. S. T. Program and has had to work overtime in spite of an expanded staff. Many departments have been extremely cooperative in arranging their work so as to enable qualified members of their staffs to help with the teaching load in physics. One professional man in business in the city also arranged to spend approximately two hours a day on the campus helping to teach soldiers. The work was mainly General Basic and 4A physics, but also included one term of 9A work, with 88 soldiers registered in one or more of five graduate courses. This heavy teaching schedule superimposed on a small but nevertheless appreciable civilian load stopped all faculty research.

Mathematics Department—The Mathematics Department has been carrying on a strenuous program in connection with the A. S. T. P., which is expected to diminish in intensity. During the lull anticipated, extensive plans will be formulated for an increased activity in the department following the war. These plans are to renew interest in mathematics for increased needs and knowledge in the post-war world.

Wartime Activities of Science Faculty Members

Several departments report specific activities of their faculty members.

Botany Department and Agricultural Experiment Station—Dr. W. M. Atwood, Professor of Plant Physiology. Because of low registration in Botany, Dr. Atwood was transferred temporarily to the Department of Physics.

Dr. Helen M. Gilkey, Associate Professor of Botany and Curator of the Herbarium. While teaching loads are low, Dr. Gilkey has been devoting her entire time to problems of the Herbarium and the technical advisory service in connection with plant identifications (weeds, etc.) for the various agricultural and forestry interests of the state.

Dr. Ethel I. Sanborn, Associate Professor of Botany and Paleobotany, during the fall term, 1943, in addition to regular instruction in botany, assisted with Army courses in geography and area studies.

Dr. F. H. Smith, Assistant Professor of Botany, during the winter term, 1944, assisted with geography and area courses in the A. S. T. P.

Dr. S. M. Zeller, Plant Pathologist, conducted projects on diseases of tree fruits, cane fruits, and strawberries. Studies in identification, life cycles, and control of virous and fungus diseases of these fruit crops are part of this program designed to reduce crop losses.

Dr. F. P. McWhorter, Plant Pathologist, has maintained projects on diseases of vegetables and ornamental plants including studies in identification, life cycles, and control on vegetables grown both for food and seed, and seed treatment to destroy seed-borne pathogens.

Dr. J. A. Milbrath, Assistant Plant Pathologist, has concentrated upon vegetable diseases and diseases of nursery stock.

C. E. Owens, Professor of Botany and Plant Pathology, has conducted projects on Brown Rot and other stone fruit diseases and virous diseases of fruit trees.

Zoology Department—Most of the research activities of the members of the department are continuations of pre-war activities. Dr. Rosalind Wulzen's research deals with the stiffness factor in guinea pigs and may have direct human application possibly of value in the war effort. She and her associates have been studying the food requirements of guinea pigs and they believe they have uncovered a hitherto unrecognized nutritional factor.

Dr. Kenneth Gordon has been working on behavior and geographical distribution of the higher animals of Oregon, particularly rodents. He has directed his efforts toward identification of species involved in transmission of such diseases as tularemia, relapsing fever, spotted fever, and bubonic (syl-

vatic) plague. He has been concerned particularly with mapping areas in which such host animals occur.

Chemistry Department—Early in the war Professor Gilbert undertook and completed a project involving the physical chemistry of certain explosives.

During the past year there have been research projects under way directed along four different lines connected with the war effort. Three full-time research assistants are engaged in organic research under direction of Dr. Christensen and Dr. Pease on a government contract. No further details may be given on this work.

Under the direction of Dr. Cheldelin there is a very active research program on the study of new, accurate, and rapid means for determination of the vitamin B complex. This work is entirely subsidized by funds from the National Research Council and the Nutrition Foundation. Associated with Dr. Cheldelin is Dr. H. P. Sarett, Research Associate, and seven graduate students.

Under the direction of Dr. Leo Friedman and subsidized by the State Board of Forestry is a four-fold project on the manufacture of plastics from wood waste, manufacture of synthetic lumber from wood waste, preparation of lignin derivatives, and a study of the nature and utilization of tars and oils from wood carbonization. The work is being carried on by research assistants and has the warm approval of the War Production Board.

Joseph Schulein, Research Associate in Chemistry, has for several years been studying methods for utilization of Oregon low-grade chromium ore. This work is sponsored and supported by the Martin Dennis Company of Newark, New Jersey, on the fellowship plan.

The Chemistry faculty has taken an active part not only in technical research but has been active in the war effort as related to community affairs. First Dr. Ferguson, then Dr. West, served as State Assistant Gas Consultant in cooperation with the State Office of Civilian Defense. Dr. Ferguson also gave an E.S.M.W.T. course in the chemistry of explosives from which a number of men went into the field of war production.

Mathematics Department — Professor Preston C. Hammer spent the summer of 1943 as a mathematical and statistical consultant in the Master Scheduling Division of Vega Aircraft Corporation, Burbank, California.

The Office of Production Research and Development invited Dr. Hammer to help instruct in a course in Quality Control given in Los Angeles for the week February 11 to 18. This course was given under direction of the E.S.M.W.T. to aircraft officials engaged largely in inspection or production control.

Because of reduction of the work in mathematics, a result of disbanding of the A. S. T. P., Dr. Hammer is accepting a position with Lockheed Aircraft Corporation, beginning in April of this year. He will be staff assistant to the chief inspector and will be in charge of quality control at Factory A, formerly Vega Aircraft Corporation.

EASTERN OREGON COLLEGE OF EDUCATION

Special Wartime Services and Programs

There are 500 Army Aviation students taking pre-pre-flight instruction at this institution. Approximately 20 instructors are employed in this program. In addition, at the present time 25 U. S. Cadet Nurse Corps students are on the campus. An additional 40 or 45 are expected to enroll during the spring term. These students are taught by the regular faculty members.

UNIVERSITY OF WASHINGTON

Special Wartime Services and Programs

In the training program field, the University of Washington has two groups of trainees on the campus, a Navy V-12 unit, including basic Navy V-12, a Marine unit, the N.R.O.T.C., comprising about 1,300 trainees, and an A. S. T. P. unit, including Army trainees in the Foreign Area and Language curriculum and advanced R.O.T.C., comprising about 325 trainees. In all probability, the A. S. T. P. program will be closed out on April 1.

The Navy V-12 training program has

put a tremendous burden on many departments, particularly Physics, Mathematics, and the College of Engineering.

Another large wartime program is the Emergency War Training Program in cooperation with the United States Office of Education. This program is under direction of Dean E. A. Loew of the College of Engineering. It has been in operation since 1941, offering a variety of nearly 150 different courses, all of college grade, mostly in the engineering field, and ranging from elementary to post-graduate work. These courses are designed primarily as training requisite to present or future employment in war industry. Most of them are offered in the evening and on Saturdays and many of them are given in large defense plants in nearby towns, such as Bremerton and Everett.

The laboratories and research departments are also currently conducting much experimental work for the Army, the Navy and the government. Much of this work is of a confidential nature. Research being carried on by the Applied Physics Laboratory is in this category. The Applied Fisheries Laboratory is also carrying on important research for the government on the effect of X-ray on fish to improve the food supply.

A major research project is one on the utilization and neutralization of liquid mill waste, made possible by the contribution of from $300,000 to $500,000 to the University by Washington pulp and paper mills. This research is being conducted by the Graduate School, looking toward solution of waste disposal and to find commercial uses for hundreds of tons of pulp liquid which now go to waste. Research already conducted by the University and the industries has indicated that vast quantities of lignin, sulphur, sugar and other ingredients of the waste liquid should be adaptable to useful purposes which would result in important new industries for the state. The purposes of the project are to find a practical method for the neutralization of pulp and paper mill liquors and wastes, and to find a method for the recovery and commercial utilization of lignin, sulphur, sugar and other materials now wasted in the manufacture of pulp and paper. Patents which may be developed as a result of the research will become the property of the University Foundation for Research, with shop rights granted to the contributing mills.

Wartime Activities of Science Faculty Members

Dr. H. K. Benson, Professor and Executive Officer of the Chemistry department, is chairman of the committee on the liquid mill waste research and also chairman of the University's committee on Lignin and Cellulose Research.

Professor Joseph E. Henderson and Professor Donald H. Loughridge of the Physics department are both engaged in wartime research projects of the Applied Physics Laboratory.

Assistant Professor Lauren R. Donaldson and Professor James E. Lynch of the School of Fisheries are conducting the X-ray research on fish.

Professor Clinton L. Utterback, Director of the Physics Laboratories, is giving much of his time to wartime research in this field as well as directing an expanded program of teaching physics to Navy trainees.

Professor William F. Thompson, Director of the School of Fisheries, is giving much of his time to wartime research projects in his department.

THE STATE COLLEGE OF WASHINGTON

Special Wartime Services and Programs

Under the Army Specialized Training Program, units in Engineering and Veterinary Medicine are on the campus, in addition to an Army Air Forces College Training detachment. The campus resounds to the tread of marching feet and uniforms are everywhere.

Wartime Activities of Science Faculty Members

Several special wartime contracts and projects are in progress, the most important of which are outlined below. In addition many individual faculty members are engaged upon specific projects growing out of the war effort, as are the staffs of the Experiment Sta-

tions. Space does not permit a detailed report of these varied activities.

Office of Scientific Research and Development contract, Physics. Full-time staff members: Paul A. Anderson, head, Department of Physics; S. Town Stephenson, Associate Professor of Physics; Kenneth E. Fitzsimmons, Instructor in Physics.

Office of Scientific Research and Development contract, Engineering Experiment Station. Homer J. Dana, Acting Director, in charge.

Light Metals Alloy Castings contract, with Boeing and Douglas Aircraft Companies. Under this contract more than 30,000 castings have been supplied. This work is in charge of Eri B. Parker, Associate Professor of Mechanical Engineering. Under his direction are Robert Taylor, full time, and Arthur S. Leonard, Assistant Professor of Mechanical Engineering, part time.

National Advisory Committee for Aeronautics contract. Howard H. Langdon, head, Department of Mechanical Engineering, in charge.

Washington State Planning Council Project, permanent mold castings of light metal alloys. Eri B. Parker and Arthur S. Leonard.

Washington State Planning Council Project, applications of light metal alloys in mechanical design and construction for post-war industries. Eri B. Parker.

Washington State Planning Council Project, alumina from clay. Otto Redlich, Research Associate in Chemistry, in charge. Working under his direction full time are Mark Adams and Jay Taylor, and as part-time assistant, Edward Holt.

Washington State Planning Council Project, alumina from clay, sulphate process. A. E. Drucker, Dean, School of Mines and Geology, in charge. Working full time under his direction are C. C. March and F. H. Sharp, Research Metallurgists.

National Nutrition Committee grant for studying nutrition education in elementary schools. This project is in Snohomish county, Washington, in charge of Thyrza Sperry, formerly Home Demonstrations Agent, Lincoln county. The study is under general direction of Miss Velma Phillips, Dean, College of Home Economics.

WHITMAN COLLEGE

Special Wartime Services and Programs

Whitman has in operation a Navy V-12 program training boys in the General Basic curriculum, Premedical, and Predental work, and also a Navy V-5 program for Naval Aviation Cadets.

The following are new members of the Science department: Dr. William Hutchings, Associate Professor of Physics and Mathematics; Dr. Phyllis Hutchings, Assistant Professor of Mathematics and Astronomy; Glen Woodward, Instructor in Chemistry; Mrs. Pearl Colby Miller, Instructor in Mathematics.

WHITWORTH COLLEGE

Special Wartime Services and Programs

Until a few weeks ago Whitworth College was conducting one of the Civil Aeronautics Administration War Training Programs, called the Army Secondary Flight Instructor Program. This program was discontinued because the emphasis in conducting the training was shifted from training of large numbers of men needed for the initial manning of our air forces to the training of those needed as replacements. This reduced the need for training additional flight instructors. The College is now in the process of completing arrangements for the entry on the campus of approximately 100 to 120 members of the United States Cadet Nurse Corps. This program will not be instituted until June.

Mr. Tuveson, instructor in chemistry, is also engaged by the Spokane Air Depot.

MONTANA STATE UNIVERSITY

Special Wartime Services and Programs

College Training Detachment 317 (Aircrew), was instituted March 1, 1943, and is continuing.

Army Specialized Training unit 3968 was in operation from September 1943 until inactivated February 1944. This

unit consisted of 30 men previously enrolled in the R. O. T. C. unit.

Engineering, Science, Management War Training courses presented: two courses in Radio Technology (in 1941-42 and 1942-43), two courses in elementary Engineering Drafting, one course in advanced Engineering Drafting (in 1943-44).

Civil Aeronautics War Training Program was established as Civilian Pilot Training, October 1939 to July 1, 1942 continuing as C. A. A. War Training Service, July 1, 1942 to March 1, 1943.

The services of a large majority of science faculty members have been utilized in carrying on the wartime programs, principally the Air Forces Training Detachment.

MONTANA STATE COLLEGE

Special Wartime Services and Programs

Montana State has some 500 men of the 312th College Training Detachment of the Army Air Forces, and Army Specialized Training unit No. 3936, which, until March 17, comprised nearly 500 men. Since that date only Enlisted Reserve Corps students remain in the A. S. T. P. and numerous courses in the E.S.M.W.T. program which have been running for more than two years.

In addition this institution has a large group of cadet nurses under provisions of the Bolton Act. Up to the present time a total of 430 prenursing students have taken part in this program. Also, 368 students are registered in affiliated hospital nursing education programs. Fifty nursing students in 1942-43 and 24 during the current year have taken the five-year course toward a baccalaureate degree in nursing.

The Science Division has furnished the main part of the instruction for the 312th College Training Detachment (Aircrew) as well as the A. S. T. P. and the nursing program. Instruction in these three programs comprises the greater part of the wartime activities of science faculty members.

MONTANA SCHOOL OF MINES

Special Wartime Services and Programs

About ninety per cent of the enrollment at Montana School of Mines consists of trainees under the Navy V-12 College Training Program. These students are engaged upon the engineering curricula prescribed by the Bureau of Naval Personnel. In addition, upper classmen who were taking part in the V-1 or V-7 programs and who were already launched upon the study of mining and metallurgical engineering, are completing work in these fields.

Wartime Activities of Science Faculty Members

The scientific and engineering personnel is continuing, so far as other duties will permit, research related to the war and post-war utilization of Montana's mineral resources.

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NORTHWEST SCIENCE

May, 1944

Vol. XVIII, No. 2

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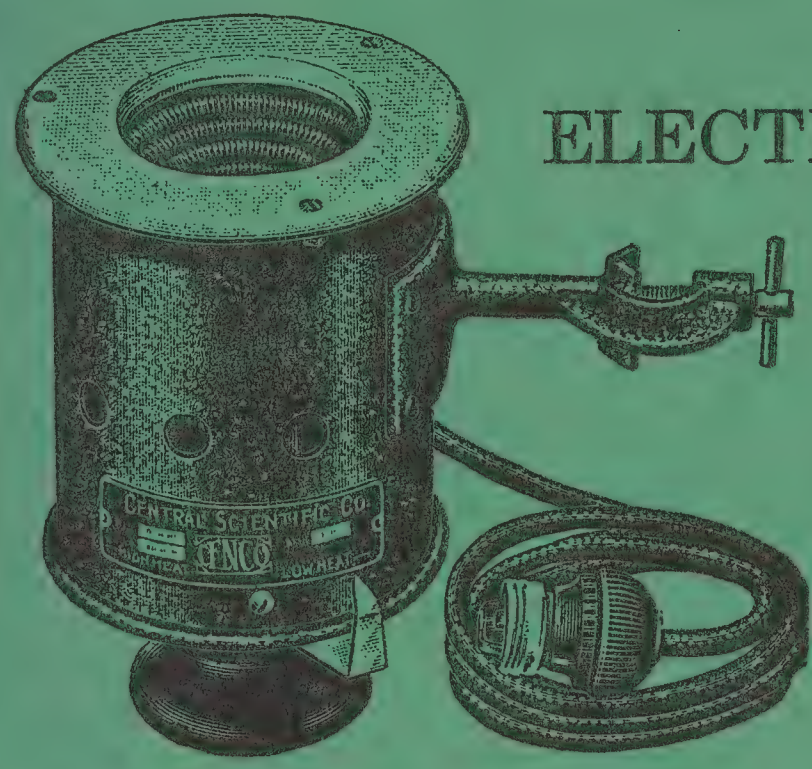

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Volume XVIII, Number 2

1944

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL. XVIII, NO. 2 MAY, 1944

Published October 30, 1944

Editor, W. R. HATCH, State College of Washington

To the Members of the Northwest Scientific Association:

The war changes conditions so rapidly that "I just keep writing along." No sooner had Dr. John Ehrlich accepted the editorship of NORTHWEST SCIENCE than he was drawn to the University of Minnesota as Research Associate in the penicillin program. Dr. A. W. Slipp finished the job of editing the delayed February issue of NORTHWEST SCIENCE. I think you will all agree that Messrs. Ehrlich and Slipp did a fine job on that issue. Dr. Slipp, however, could not continue as editor, since he was going into the field for the summer and a part of the autumn. A group of officers met as an executive board in Spokane about the middle of April. As a result of this meeting, Dr. W. R. Hatch, Head of the Department of Botany at the State College of Washington, was urged to—and agreed to—serve as editor pro tem. With your help, if Dr. Hatch requests it, I am sure that the Association can continue to publish NORTHWEST SCIENCE for the duration.

We are getting low on current funds. We don't want to "tap" our reserve if we can avoid it. The response of the membership to the request for dues has been gratifying. Won't those of you who have not yet taken the time, respond by sending one dollar, (more if you are in an "expansive" mood) to Professor J. W. Hungate, Department of Applied Sciences and Arts, Eastern Washington College of Education, Cheney, Washington?

As many officers of the Northwest Scientific Association as can get away, will meet again in Spokane in the early autumn to consider the affairs of the association. If you have any suggestions or criticisms feel free to write any of us. We will keep our eyes on the war and its demands upon travel and hotel facilities. As soon as such facilities are generally released for civilian use, we shall resume the annual meetings, thus far suspended during the war emergency.

J. W. SEVERY, President.

BACKSIGHT AND FORESIGHT ON LAND USE[1]

W. A. ROCKIE
Soil Conservationist, Soil Conservation Service, Portland, Oregon.

Frank Hardy was ambitious. In 1905 he owned a 160-acre farm in eastern Nebraska worth about $9,000.

One day, when he was shipping a load of hogs to Omaha, he saw a land advertisement (plate 1) on the wall of the waiting room at the "depot."[2] He stopped to read it and became much interested. The poster told about millions of acres of open government land in Oregon that yielded 60-bushel wheat crops and had no crop failures.

This looked good to Mr. Hardy, and so, taking the advice on the poster, he sent to the land agent of the railroad named thereon for more information, and a booklet (plates II and III) soon arrived by mail. It looked even better than the poster he had seen in the depot.

The Hardys read the contents of this bulletin again and again. It intrigued and fascinated them. It made them dissatisfied with their Nebraska farm. The upshot of it was that within a few weeks they sold their Nebraska farm and moved to Lake County, Oregon.

The writer has had a series of rather intimate contacts with the conditions connected with the Hardys' move out West.

In either 1906 or 1907, a railroad agent in a Nebraska town offered him a job. He inquired as to its character and was told: "Here are 30 of these large posters. We want them mounted in prominent places on the walls in the passenger station waiting rooms in 30 towns in eastern Nebraska." He provided a list of towns. "We will give you a pass, money for your expenses, and five dollars for doing the job."

To a high school youngster of that decade, the pass and the expense money would have been adequate. The five dollars was pure "velvet." The job was accepted. The posters were of heavy cardboard and, as recalled, they were approximately 3½ feet wide and 6 feet long.

During the execution of this job, the headlines of this poster made a deep impression. Those headlines were somewhat as shown on plate I. The statements which made up the body of this poster cannot be recalled. However, they included a detailed description of land and farms and crops.

As far as the writer was then concerned, that job for the railroad ended when the last poster was tacked to the wall. Years passed, during which time he specialized in soil and land problems at college. He worked several years on land problems for the University of Nebraska, for the United States Department of Agriculture, and for private land firms in Nebraska, Iowa, Kansas, and Colorado.

In 1918, he began work classifying public domain and homestead lands in central Oregon for the Land Classification Division of the United States Geological Survey. While so engaged, his task included an examination of large areas of abandoned 320-acre homesteads in northern Lake County, Oregon.

While inspecting these abandoned farms, the writer found, nailed over a broken window in an empty house, a dirty and torn cardboard poster *identical with those placed by him in the Nebraska railroad stations* some twelve years earlier.

The statements on this poster were now doubly interesting, for the land described therein in such glowing terms lay before him, extending in all directions. These abandoned lands were the "wonderful farm lands" of the poster and of other similar advertising.

The headline of the poster (plate I) assumed greater significance because "Imperial, Portland and Seattle, the great cities of the Northwest," were now familiar places. Imperial was purely imaginary, although it was shown as an actual location on some of the old maps of 25 years ago. It simply never grew to cityhood; in fact, it never actually attained townhood. It was shown

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[1] Presented before the History-Geography Section, 8th American Scientific Congress at Washington, May, 1940.

[2] Local Midwest term for "railroad passenger station."

on the maps for a brief period, not because of any physical existence, but solely because widespread advertising said a certain spot in the sagebrush was to be called "Imperial." Portland and Seattle were mentioned only to accentuate and support the claims being made for Imperial.

The next sub-headline on the advertisement "The Palouse Region of Oregon" compares this central Oregon area with the famous Palouse[1] region of Washington and Idaho. These lands were represented as being of similar character to those of the Palouse, although there is less similarity between these northern Lake County lands and the Palouse lands of Washington and Idaho than between the best Iowa farm and the poorest farm in the famous "Dust Bowl"! There is no Palouse Region of Oregon!

A typical township[2] was selected for closer study. The status of the seventy-two 320-acre homesteads therein was found to be practically 100 percent abandonment in 1918. The land had been settled originally in 1907-09. This study showed that 11 of the 72 farmers in this one township had come from farming territory contiguous with the same 30 towns in eastern Nebraska where the writer had tacked up his posters. Undoubtedly, several times this number had sold their good Nebraska farms and migrated to others of the dozens of townships in the "promised land" of central Oregon. Many hundreds of the settlers on these lands came from other states in the Midwest. They had been attracted by other copies of the same cardboard poster placed in other railroad depots by other youngsters in other parts of that section.

The highly advertised lands of northern Lake County had within ten years failed completely as farming lands. They have remained practically bare—their soils drifting with every wind—ever since they were first broken from sod before 1910. During the past 30 years, from all practical aspects, this area has been a desert; it could have continued as productive cattle range. In 1939, the Soil Conservation Service was authorized through federal purchase of submarginal land to undertake the return of a small portion of these abandoned lands to a grass cover. In time, these lands, first plowed 30-odd years ago, which failed to produce a single paying crop, and have remained bare and blowing during the intervening years may, following treatment, again possess some value as grazing land.

Today large areas of these lands are practically without value. As a matter of fact, in private ownership these lands generally have failed to pay taxes, first, as 320-acre homesteads, later, as larger farms through purchase from emigrating, discouraged neighbors, and still later, as the larger ranch holdings of more recent years. Tax delinquency has typified the area, although a few scattered ranch owners who possessed the free use of considerable areas of public land adjoining their personal holdings have been able financially to maintain clear title to their holdings.

The Frank Hardy incident is not an indictment of any particular railroad or of Oregon alone, because equally misleading advertisements were backed, promoted, and displayed before a gullible public by every western railroad and by each of our western states. This case is used as an illustration because the writer was personally acquainted with it. Fortunately, such a situation could not arise today. Both the railroads and the states have now recognized that such advertising is bad business. Today, manufacturers, distributors, railroads, bankers, in fact organizations and individuals from all social and commercial levels are becoming conservation-minded. The following publications with conservation as an objective give evidence on this point:

1. *Crops or Canyons,* by Caterpillar Tractor Company.
2. *Crops for Safe Farming,* by American Bankers' Association Agricultural Committee.
3. *Protecting Investment Values on Land,* by American Bankers' Association Agricultural Committee.

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[1] Rockie, W. A., Man's Effects on the Palouse. The Geographical Review Vol. XXIX, No. 1. January 1939.

[2] A six mile square, containing 36 sections or square miles.

4. *Strawberry Clover,* by Union Pacific Railroad.
5. *Save Soil and Moisture by Strip Farming,* by Great Northern Railway.
6. *Modern Power Farming,* by Allis-Chalmers Mfg. Co.
7. *Green Acres,* Pamphlet No. 118, by National Fertilizer Association.
8. *Soil & Moisture Conservation in the Western Plains Area,* by the International Harvester Company.

These show that industry is becoming genuinely interested in the conservation movement. However, there still are in every section of the country some land agencies whose advertising of lands would not stand close inspection.

Although the Frank Hardy, mentioned at the beginning of this paper, is a fictitious person, there were thousands of "Frank Hardys" who actually sold their good farms in the middle western states, moved out west, and lost everything because of misleading statements about land.

Frank Hardy was trying to better his position in life. Had the facts been as stated in the advertisements (plates I-III) he would have succeeded, but the "field work" which resulted in the preparation of this poster and this bulletin had been a bit careless—with tragic results to the Hardys.

Had Frank Hardy remained on his Nebraska farm he would probably have been a comfortably-situated Nebraska farmer today. Instead he became a drifter, logger, ranch hand, migrating farm laborer, janitor, town handy-man, and finally a relief client. He never again attained an independent position in life.

Land tragedies such as this have overtaken at least a million farm families in the United States. Exaggerated land advertising such as has been described should never have been permitted. Such things did occur, however, because for the most part, nobody, not even our Federal government knew positively whether the claims made regarding certain lands were strictly true or grossly exaggerated. Furthermore, neither government nor individual took any responsibility in opposing such misrepresentation. Reliable information about land could seldom be obtained in advance of development.

The lands referred to in plate III as "rich, black loam that grows wheat which will average sixty bushels to the acre" never did have a rich, black loam soil, and never raised 60-bushel wheat crops. Without irrigation, most of these so-called farm lands in Lake County do well to produce a crop of Russian thistle.

Practically all of the land settlement of the public domain in western United States just happened. Such planning as was done, was based on misstatements and fallacies. The government made no plans whatsoever. Settlement came as a result of (1) our policy of free land for everyone, (2) an open-door immigration policy, (3) wholesale development of unsound irrigation projects, and (4) our silent permission of unregulated, unsupervised, and fallacious advertising of these raw lands. A brief analysis of the four factors just mentioned will clarify the writer's statement.

The homesteads that were taken up to 1890 were largely on good land. As a result, homesteads were in high repute. Homesteading of the semi-arid lands, most of which have since grown into complex problems for land adjustment, had not really begun. In the absence of information to the contrary, it was naturally assumed that the remaining homesteads would prove equally desirable. By doubling the acreage of the homestead in 1909, and again in 1916, the government indicated its recognition of the fact that the lands offered for homesteading were less valuable than those offered formerly. However, this increase in size was insufficient to offset the lower productivity of the more recently offered lands.

Our immigration policy invited almost anyone to obtain citizenship and thus to become eligible to homestead. Because most of these immigrants from foreign countries were land-hungry people, they, along with other United States residents, grabbed homesteads regardless of quality.

Too large a percentage of the early irrigation projects had been inadequately investigated beforehand. Many erro-

IMPERIAL PORTLAND & SEATTLE

---THE GREAT CITIES OF THE NORTHWEST

THE PALOUSE REGION OF OREGON

(A very detailed description was given here of the agriculture in the Palouse region proper.)

For further information write to

..... Railroad

.....City, ...State,

or ..... State Immigration Bureau

.....State.

Plate I—An approximate replica of posters distributed in Nebraska by writer.

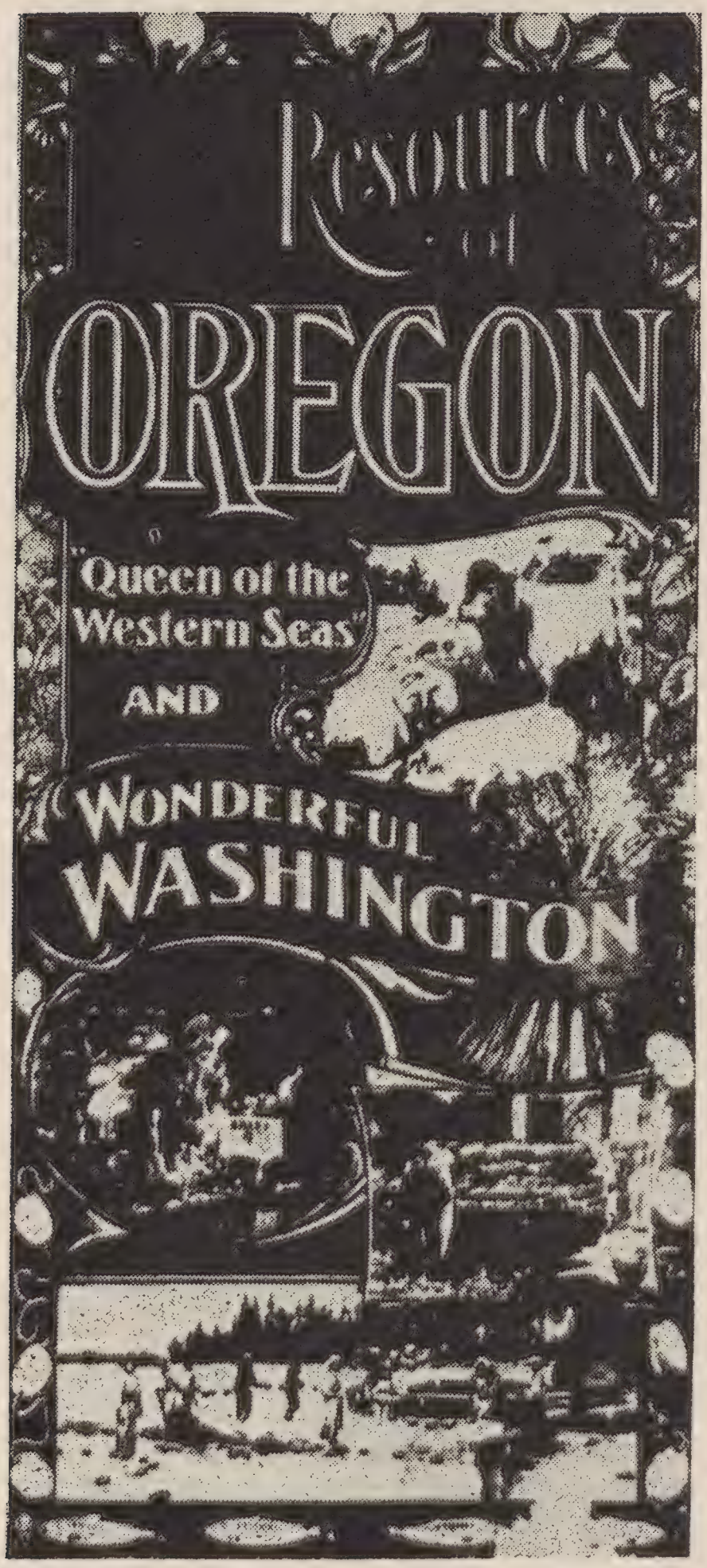

Plate II—Front cover page of booklet sent out by railroad to farmer in Nebraska.

Field of Alfalfa

largest, best known, and most valuable tract lies north of the Klamath River and is known as the Jenney Creek Belt.

Klamath County has 1,800,000 acres of Government land unappropriated and open for settlement.

Lake County

Here is a county with a total area of land surface of 5,049,300 acres, and of this 4,200,000 acres are still open for settlement. Thirty years ago this section had among its population not more than ten white persons, and now its white population is 6,000. The county is prosperous and never more so than at the present time. The soil consists chiefly of a rich black loam and grows wheat, which will average sixty bushels to the acre. All varieties of fruit, such as apples, pears, prunes, plums, cherries, and all kinds of berries, grow in abundance. Lake County does not fear to place her apples for comparison beside that fruit grown in any part of the world.

Lake County has 4,200,000 acres of Government land unappropriated and open for settlement.

Harney County

This county is 140 miles long and seventy miles wide and contains about 6,200,000 acres of land. Harney County could easily support a population of 350,000 people. Timber dense and majestic and of fine quality for lumber or firewood covers the mountain sides. The soil along the river bottoms is a mixture of vegetable mould and sediment and produces a variety of natural grasses, which make a fine quality of hay. Wheat, barley, and rye grow in abundance, and hardy fruits can be produced here to perfection. The product of the orchards are singularly free from defects caused by insect enemies.

Harney County has 4,500,000 acres of Government land unappropriated and open for settlement.

Malheur County

Contains 6,400,000 acres of land and lies in the southwestern part of the State. t is watered by two rivers, the Owyhee and the Malheur, and these with numerous tributaries furnish an immense volume of water for irrigating purposes. All the land bordering these streams is of the very best, being generally covered in its wild state by a rank growth of sage-brush and rye grass and is easily cleared. Agriculture has made great strides in the last few years.

Plate III—Page 23 of same booklet telling about agriculture in Lake County, Oregon.

neous assumptions were drawn which careful investigation would have obviated. Investigation today shows some of yesterday's mistakes.

The major cause of the land difficulties in western United States today, however, lies in the untrue advertising of an earlier period. Some of it was innocently and ignorantly done, but most of the promoters winked at careless handling of facts to make the land descriptions more attractive. Limited investigation of some of these lands had been made prior to settlement, but generally the advance work consisted only of setting the section corners to mark the boundaries between farms. The government policy as we view it in retrospect, should have included at least some experimental recommendations for land use, but the continued demand for more and more homesteads disposed of these millions of acres before any adequate thinking along the lines of land planning developed.

Homesteading and other methods of land settlement, including purchase, continued until the present decade. Only within the past ten years was a field inventory begun to determine the results of the land orgy through which the United States had passed. Earlier studies, on selected but exceedingly limited areas, formed the basis for beginning this more recent nation-wide inventory. Now all of the public domain lands in the United States have been withdrawn from homestead entry. This "locks the stable," but "the horse has already been stolen."

The development of the lands of the United States continued until farms could no longer be carved from raw lands open to homesteaders in western states from a beneficent Uncle Sam.

Now we are trying to readjust the use of these abused and exploited lands, these adjustments including such social and economic changes as are necessary to accomplish erosion control and proper land use. Also large areas of range land[1] which are still public domain are actively eroding even though undeveloped. This is the result of overgrazing by trespassing livestock.

In some of the older farming sections, and also in a few of the more erodible areas of the younger farm lands, hope of continued cultivation of vast tillable areas is gone. On most of the farm lands of the United States there exists a definite need for the adoption of safer, more permanent methods of land use. The work of the Soil Conservation Service in the United States is directed toward changing our farming to a better, safer and more permanent use of land.

Dr. H. H. Bennett stated in 1933[2], "We are 75 to 100 years behind with our studies relating to these processes (of soil erosion) and to methods of controlling them. We have diligently studied almost every other agricultural subject but this one, the one which should have been studied first."

Secretary of Agriculture Henry A. Wallace in 1939 said, "The essential fact is that while the nation slept, the problem of wastage of soil and forest and water crept upon it."

This year, in 1940, Dr. Bennett[3] stated, "The work of conservation should have started a century ago, perhaps even earlier."

The present activity designed to prevent destruction of our farm and range land by erosion is the result of a partially aroused public consciousness that serious land problems actually exist. But the seriousness of the situation is not yet adequately realized.

Although the free farm lands in the United States are gone, there are still many millions of tillable acres which have not attained their full use. The U. S. Reclamation Service, for example, is engaged in the construction of Grand Coulee Dam in central Washington for the purpose of irrigating some 1¼ million acres of fertile but quite arid land. Some of this land had been broken, dry farmed for a decade or more, and then in many instances abandoned. Much of it still remains as range. Both the original unplowed ground and most of these temporarily cultivated areas are practically virgin land.

Erosion problems, particularly the one of soil drifting, have developed on these dry-farmed lands and to some extent on the range land. This drifting was one of several important factors which caused the farm abandonment. The land is fertile, and it has not yet

been ruined. A new, more intensive use of it is now proposed. Serious erosion problems already exist, however, on similar irrigated lands in most parts of the west. Therefore the occurrence of serious erosion problems is anticipated in connection with these new land developments unless especial efforts to prevent such damage are made. Our past unfortunate experiences should teach us that we will not—we can not—have too much information about the land if it is to be saved for continuous productive use.

Estimates show that the United States government will have a total investment of about $400,000,000 in the Grand Coulee project. Prorated cost charges are to be distributed, however, leaving between half and two-thirds of this amount as the net investment of the government. The individual landowners will each have a large initial cash investment in the land and buildings. This original investment will be followed by a continuing investment of planning, time, materials, labor, and money during the coming decades. Estimates by different authorities indicate that the ultimate resultant development, both rural and urban, will provide homes and sustenance for between one-half million and one million additional persons. This is the equivalent of another State of Idaho, or if the larger estimate were attained, a new Oregon would be added. The total investment (Federal, State, county, city, and private) in this one new project area may soon reach almost a billion dollars.

It is highly important, therefore, that the development and use of such lands be made safe. Such land under past use is not safe either from soil drifting or soil washing. Future developments and use will not be safe without adequate precautions and safeguards against land damage. These need to be planned in advance, preferably with the first tillage of the soil. The need for added study of the many problems that are involved was recognized by the administrative officials in charge. They already have appointed an outstanding land-planner of the United States to direct its development.

In the Grand Coulee project and in other areas, such as those to be irrigated (1) from Boulder Dam, and (2) in the Central Valley of California, erosion should be prevented and proper land use should be attained by advance planning. This would be attacking the problem at a time when its proper solution is easier and less expensive.

Many smaller areas of new land are being developed as new irrigation projects in all of the western states. The nation has an opportunity in all these new areas to initiate safe land use when it would be most effective—at the outset.

Cut-over timber lands represent another important source of new land that will be added to our agricultural domain. In certain localities, such as western Oregon and western Washington, there are vast areas of timber land, virgin or burned or cut-over, and one of the more favorable climates in the entire nation. Such lands should be guarded carefully against future damage. They are adaptable to use in many different ways and potentially are among the more valuable lands in the country. Studies of cut-over lands and their land use capabilities have not been sufficiently detailed to provide a reliable factual base.

A third category of virgin land, and potentially by far the largest includes the vast acreage in Alaska. A recent unsigned newspaper article[1] stated that 364,000,000 of Alaska's 380,000,000 acres are still open to homesteading. Field studies of some of the homesteads that have already been taken and developed, show conclusively that damage by one or another type of erosion just as certainly will strike the lands of Alaska as has been the case in the United States. Field studies also show that many millions of acres, possibly enough for a million farm homes, can be developed in Alaska for use along agricultural and livestock lines. Preliminary

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[1] Range land—Mainly hilly land, but sometimes includes valley lands too dry for farming.

[2] Soil Erosion a Costly Farm Evil—by H. H. Bennett. Farmers' Week Program, Ohio State Univ., Jan. 31, 1933.

[3] Permanent Systems of Farming—by H. H. Bennett. 13th Annual Meeting of Texas Agricultural Workers' Assoc., Dallas, Texas, Jan. 12, 1940.

studies of these areas and of their land use capabilities is essential if wise use of this land is to be attained. Scattered patches of Alaska lands now being used for agriculture already show serious damage from one or more types of erosion. The problem appears particularly serious, even from the limited studies that have so far been made.

The objective of the present soil conservation movement in the United States is to effect wise land use. To the Soil Conservation Service in the United States Department of Agriculture has been delegated the responsibility of helping to attain better use and conservation of range, farming, irrigated, drained, forested, pastured, and submarginal lands. Along with this goes better conservation and use of water. The task specifically includes advance research, experimental demonstrations in different areas, and finally the application of proven practices on all lands needing more conservative land use.

On lands already in use, this task generally consists of important modifications in the present use of the land, and on a considerable proportion of all the land in use it means substituting a new land use for the old. Most land use of the past gave no recognition to the safety factor with the result that almost all lands which were vulnerable to attack by wind or water, have suffered serious damage.

Summarized in a few words, the work of the Soil Conservation Service consists mainly of repairing man's past and present mistakes in using the land. On new lands, however, such as those types that have been mentioned in preceding pages, an opportunity exists to "lock the stable before the horse is stolen." On these lands, "an ounce of prevention is worth a pound of cure."

Thousands of "Frank Hardys" have been settling on the cut-over lands of the forested areas of western Oregon and western Washington. The settlement of these lands began long ago, but it has become a migration during the past five years.

Other thousands of "Hardy" families are eagerly awaiting the delivery of irrigation water to the lands within the Grand Coulee project and elsewhere—for therein are their hopes for the future.

Still other "Hardys" want to homestead in Alaska, and at present are deterred therefrom chiefly by the cost of transportation from the States to the Territory. They are sitting on the anxious seat waiting for the new Alaska Highway to be built and opened.

The United States Government, the particular State or Territory, the local community, and the individual who is developing the land, all gain if wise land use is practiced, while all lose if unwise land use prevails.

Adequate specific studies to aid in attaining wise land use under these new developments and on newly-settled wilderness land are a specific need (1) on all new irrigation projects, (2) on cut-over timber lands, and (3) on the potential agricultural lands in Alaska to prevent a repetition of some of the land tragedies in western United States during the past forty years.

Will America adequately meet this situation?

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[1] Washington Evening Star, April, 1938.

THE MONTANA ACADEMY OF SICENCES

G. B. CASTLE

Department of Zoology, Montana State University

The Montana Academy of Sciences as now organized is only four years old. The first Academy was formed in 1902 under the name of the Montana Academy of Science, Arts and Letters. From all available sources, the history of this first academy was somewhat as follows: It met for the first time in Bozeman, Montana, and at that meeting elected Dr. M. J. Elrod, Professor of Biology, Montana State University, President. The attendance at this first meeting was 58, a remarkable number when we remember the conditions of travel as they existed at that time. According to the report in "Science" for 1903, six papers were presented in full and four were read by title. These included papers on biological and physical science subjects and one on philosophy. Dr. J. P. Rowe, Professor of Geology, Montana State University, acted as secretary at this first meeting. From the sources at hand, it appears that that Academy continued to meet yearly until 1906. At that time it seems to have been discontinued and was never re-established.

During 1937 Dr. H. B. Mills of Montana State College, and the writer several times discussed the advisability of trying to establish an Academy of Sciences in the state and eventually interested others in the idea. In the fall of 1938 Dr. Mills, Dr. R. T. Clark and Dr. I. Thirkelsen of the State College, Dr. George Shue, and Dr. F. M. Thompson of the State School of Mines, and Dr. J. W. Howard, Dr. E. M. Little, Prof. J. H. Ramskill. and the writer of the State University, met at the State School of Mines in Butte to discuss in greater detail the formation of an Academy of Science. This group was of the opinion that there was a definite need in the state for an academy and that it would serve many purposes. In a state the size of Montana with the diverse problems which the state has by virtue of its climate and topography, it was thought that an academy could act as a clearing house for scientific work in the state. It would also make possible a better understanding of the problems in the various regions of Montana on the part of those engaged in scientific work. Likewise, because of our isolation from the centers in which national scientific organizations meet, it was thought that there was a definite need for men engaged in scientific pursuit to have the benefit of discussing with others in their fields problems of mutual interest. Following this meeting those engaged in scientific work in the state were circularized. There was found to be a considerable number of persons interested in the idea of an academy.

Finally in the fall of 1940, the organization meeting of the Academy of Sciences was held in Great Falls, Montana. At this meeting 30 scientists from various parts of the state met, four papers were presented and a constitution and by-laws were drawn up. Officers for the coming year were elected as follows: President: Dr. G. B. Castle of the State University; Vice Presidents: Dr. H. B. Mills of the State College, Dr. E. W. Schilling of the State College, and Prof. Melvin S. Morris of the State University; Secretary: Dr. Fred Barkley of the State University; Treasurer: Dr. R. T. Clark of the State College. During the ensuing year our membership grew to approximately 150. There was no active membership drive, but people who were thought to be interested were informed of the objectives of the Academy and were invited to join. Our first annual meeting held in Bozeman in 1941 had a good attendance with the presentation of 43 papers. Since Pearl Harbor our meetings have been less well attended because of the difficulties of transportation and because many of the members are participating in war activities. The membership at present is in the neighborhood of 100 and with this nucleus it is hoped that the Academy can carry through and, after the war, go ahead with its program. At present the organization embraces only the sciences.

It is to be hoped that in time other sections in the Arts and Letters will be added to the scientific group and thereby contribute further in disseminating information concerning the state as a whole. The Greater University of Montana has aided the Academy in publishing its transactions. This financial assistance has been greatly appreciated by the members of the Academy since it has assured publication being continued during the war years. The plans for future meetings are tentative but it is hoped that continuity can be maintained for the duration. The present officers of the Academy are: President: Dr. D. Q. Posin, Montana School of Mines; Vice President: Dr. Harold Chatland, Montana State University, Dr. J. J. Livers and Dr. Ellsworth Hastings, Montana State College; Secretary-Treasurer: Prof. Melvin S. Morris, Montana State University.

The Academy of Sciences in Montana will foster interest in regional and national scientific organizations. As the benefits of the state organization become apparent, members will see the opportunity for securing further stimulus and understanding in other scientific groups. State academies can act as clearing houses for problems of their individual states. Those problems which are of regional interest may then be taken to meetings of the Northwest Scientific Association. Many members of the Montana Academy of Sciences are at present members of the Northwest Scientific Association and participate in their meetings and organization.

PRINCIPLES OF FUEL REDUCTION

C. K. LYMAN

Associate Silviculturist, Northern Rocky Mountain Forest and Range Experiment Station

All foresters, ecologists, botanists, and wildlife experts in the northern Rocky Mountain region are familiar with the tangles of snags, windfalls, and other forest debris covering small patches to large portions of our forests or wildland area. Created by past forest fires, by insect epidemics, disease, and sometimes by logging, these concentrations of fuel for future forest fires not only constitute a perpetual fire menace but also interfere with the future productivity and best use of lands.

Fire protection costs are increased through the necessity of maintaining fire lookouts, smokechasers, firefighting crews, and roads and trails in the vicinity of such bad fuel areas. Firefighting costs are greatly increased due to the extreme difficulties of fire suppression when lightning or man starts a blaze within these bad fuels. The possibility of maturing the young trees which regenerate on such areas is greatly diminished. The safety of all surrounding timber is decreased. Neither livestock nor wildlife can fully utilize the forage within such tangles of windfalls. And the hunter, the fisherman, or the mountaineer attempting to cross such an area is seriously impeded in his or her enjoyment. Analysis of methods, costs, and benefits is likely to show that removal and the breaking up of bad snag patches and concentrations of dead ground fuels is the most economical means of correcting these unfavorable conditions.

POST-WAR OPPORTUNITY

Removal or reduction of these bad fuels, which are actually much more than a fire menace, should prove to be one productive and beneficial use of post-war labor. Tens of thousands of acres will probably need the work of hundreds of thousands of man-days. But the selection of the areas to be worked on and the character of the work to be done on each area cannot be left to the personal judgment of each local ranger, supervisor, county commissioner, state officer, or work relief official. There are too many beneficial projects awaiting work to permit the chance of wasteful "leaf-raking."

To establish the criteria which should be used, first in selecting areas worthy of post-war work and second in accomplishing the desired objectives with a minimum amount of work, the North-

ern Rocky Mountain Forest and Range Experiment Station is now developing what will probably be called the "Guiding Principles of Fuel Reduction." This research in the development of principles has been under way for only a few months. It has the background, however, of many years of research in both fire control planning and fire danger measurement. From those standpoints the principles are quite clear. From the standpoint of economic and social benefits, however, the derivation of principles is not at all self-evident. The present report is therefore intended to be both informational and an appeal for advice.

FUEL REDUCTION METHODS

Several well tested methods of fuel reduction can be employed to meet the local requirements for treating bad fuel messes. A few areas contain merchantable material such as cedar snags which can be utilized for fence posts and shingles, or dead spruce which is still usable for pulpwood. Here adequate fuel reduction can be attained simply by harvesting this still merchantable wood and then disposing of the worst concentrations of debris left after logging. Obviously the greatest benefits will result by using this method wherever practicable. Unfortunately there are relatively few areas where it will be profitable unless the future market for fence posts and pulpwood is better than it was before the war. Eventually technological developments may create a demand for and a practical means of harvesting the masses of dead wood on forest lands. For instance, if chemical conversion of wood becomes highly profitable, operating costs may be sufficiently reduced by developing special machinery such as portable "wood-hoggers" to grind wood into small chips right out in the forest, and big autovans to transport the chips direct to the factory "cook pot." When something like this can be done, fuel reduction will become a profitable venture not requiring Governmental subsidy. But until such advancements are made, there is sound justification for using other more destructive means of reducing fuels.

Just falling the snags will suffice on some areas where dead ground fuels of less than average amount are well shaded and protected by dense reproduction. The large volume of dead material on other areas will require snagging followed by carefully controlled broadcast burning. Many tests have been made proving the feasibility of broadcast burning large areas without chancing disaster. A few areas were treated in this manner when the Civilian Conservation Corps was available for such work.

On the very largest bad fuel areas where size prohibits treating the entire area, wide strips will probably have to be cleaned up and later planted with some fire-resistant tree species. Larch is known to be such a species. Careful analysis of local conditions may show that spot burning or the construction of narrow fire lanes will be adequate in other places.

The character and interrelationship of all factors such as fuels, topography, weather, ecology, soil conditions, fire, etc., must be judged when prescribing methods best suited to different localities.

FIRE CONTROL BENEFITS

Probably the most obvious benefit of fuel reduction is the increased chance for successfully controlling fires after bad fuel messes are properly reduced. If man creates easier fuels having few snags in the air and only a small volume of dead fuels on the ground, fewer fast-spreading fires will develop before suppression crews can reach them. Also, more fires can be controlled more easily and more quickly after men arrive because fewer snags have to be felled and good fire lines can be constructed without cutting and throwing out as much debris. All this means savings in the cost of suppressing fires. Other important savings can be made because more severe weather conditions are required before fires will spread dangerously fast in the easier fuels. Fewer smokechasers and fire crews will have to be employed. Fewer facilities such as fire-guard stations, trails, and roads will be needed.

Reliable estimates of these potential savings cannot be made without infor-

mation concerning the number of large fires and the area of burn that can be avoided by reducing fuels. Past records provide adequate guides for judging this.

From 1931 to 1943 over 690,000 acres were burned on lands protected by the Forest Service in North Idaho and western Montana. More than 80 percent of this burn was created by fires that started in or first "blew up" in fuel types classified as worse than medium rate of spread and medium resistance to control (Medium-Medium). Even more surprising—60 percent of this 690,000 acres burned was caused by fires starting or "blowing up" in very bad fuel types classified as High-High and worse. Yet these High-High and worse fuels comprise less than 5 percent of the total area protected.

One factor which must not be overlooked in planning for future fuel reduction is Nature's effect on fuels. Special studies have been made to analyze the relative effects of this factor. Nature increases fuel badness for the first few years after dangerous fuels are created. (The period varies from 15 to 30 years.) Then she starts reducing the menace partly by weathering, leaching, and decaying dead wood and wind-throwing snags, and partly by providing shade which itself helps to lower the fuel type rating by maintaining more moist fuels and lower wind velocity. She reduces some by reburning them a second or third time. Today more than 75 percent of the bad fuels created by the 1910 fires have been reduced to the easier fuel type ratings as a result of Nature's own processes. Many of the present-day High-High and worse fuel types are expected to rate less by 1950. Today there are only 647,000 acres of these really bad fuels. By 1950 only about 320,000 of these acres will rate as bad. Close figuring of costs and a willingness to assume some risk may therefore show justification for taking a chance with the bad fuels which Nature herself will reduce within the next few years. One of the first principles of economic fuel reduction is therefore to rely on Nature to do the job, IF she will do it soon enough.

When all physical effects such as the above are properly appraised, economic methods can then be employed to help determine the amount and type of fuel reduction that will create the most benefits per dollar expended.

ECONOMIC APPRAISAL

There was a time—and not so long ago—when the appraisal of needs and justification for public work projects were founded almost entirely on judgment, opinion, or even politics. Needs were expressed in words flavored with "hunch" and "personal preference." The benefits to be derived were considered but only in a figurative and qualitative sense. Recent progress in the science of social economics, however, shows that the responsibilities of promoting maximum public welfare cannot be met without using economic evaluations as a guide in planning and policy formulation.

One primary objective of our fuel reduction study consequently is to select and evolve practical methods of applying economic principles which can be used in making the most accurate and complete appraisals possible. Principles are needed that will enable planners to determine the most favorable relationships between costs and benefits.

Because money is the only commensurable standard of value, costs and benefits should be evaluated in monetary terms whenever possible and practicable. But dollar values should be assigned *only* when the knowledge of fire effects permits reasonably accurate measurement or estimation and when the wildland resources in question are or will be needed and can be made available.

The effects of fire in damaging timber is one factor which can be measured and which can be evaluated in monetary terms if the timber has present or potential merchantability and accessibility. Other evaluable factors are: (1) costs of fuel reduction; (2) savings in fire protection expenditures; and (3) benefits from increasing the volume and quality of timber or from improving range lands. There are other factors, however, which are irreducible to monetary terms. The unfavorable and

favorable effects of fire on soil and water yields are factors which existing knowledge and difficulties of measurement do not permit evaluating in dollars and cents. No one has yet discovered a practical means of expressing the monetary value of aesthetics and recreational enjoyment. These irreducibles or intangibles cannot be ignored, but they must be considered, using judgment guided by the best available evidence.

A brief discussion of some important fuel reduction benefits will help to explain the nature and scope of the economics involved. If some large fires can be prevented, a great deal of timber damage can be avoided. The present value of timber that can be saved by fuel reduction now represents one of the major benefits to be obtained. Heretofore timber damage appraisal has not included anything beyond stumpage value. Recent progress in a national fire economics research project under the immediate supervision of Bernard Frank, however, is providing practical means of more fully evaluating the interests of society in the timber killed by fire. Methods are being devised that will permit appraising the net monetary losses not only to the landowner but also to the logging and mill operators, the wage earners, and the service industries such as grocery stores, service stations, and liquor stores dependent upon these workers. The losses in taxes paid by these industries and workers is also receiving attention.

Actually, the effects of fire on the landowner are not fully represented by appraisals of stumpage value alone. The value the landowner receives from salvaging burned timber should be deducted from the loss in stumpage value. His future costs of managing timberlands may either increase or decrease when large quantities of timber are fire-killed. For instance, the need for costly timber cruising may be eliminated, or if bad fuel messes are created the costs of fire protection may be radically increased. Also, management plans may have to be revised. All of these effects must be accounted for if the true influence of fuel reduction are to be judged.

Logging and mill operators always suffer losses whether they own the damaged timber or not. Their profits and operating income are reduced immediately if their crews have to take time out to fight fire. They may have to contribute men, supplies, and equipment to the control of the fire. When large quantities of merchantable timber are lost and cannot be replaced by cutting elsewhere, the output of mills and logging concerns will eventually have to be reduced, and the discounted value of the lost profits should be considered as a part of the fire damage. Of course this loss ordinarily will not equal the gross income loss in the timber business because some of it can be made up by investing money and energy elsewhere. Research is needed to determine how *conservative* estimates of this factor should be made.

Similar losses are suffered by laborers and wage earners. There may be an immediate loss in their income because of work stoppage or wage reductions created by the necessity of fighting fire. Reduced work opportunities or lower rates of pay resulting from timber depletion may cause future income losses. Here again the effects should be moderated to account for alternative opportunities of work in fields other than timber production. Most men will find other employment, and in many cases there will be some earning loss resulting from unemployment while hunting other jobs. Studies are needed to determine just how this factor should be measured.

The earning power in a community has an important influence on the profits of service industries such as grocery stores, garages, and even barber shops. This influence is readily susceptible to evaluation once labor and capital income losses are known.

The sum of all these losses represents the major portion of society's interest in fire-damaged timber. The total amount is likely to equal as much as two or three times the stumpage value. If research proves there is a direct relationship between total public losses and stumpage value, a practical method of appraisal can be devised. Total economic loss can be figured simply by

applying a conversion factor to stumpage value.

The public interests in wildland resources other than timber are similar to those discussed above. If the effects of fire on those resources can be measured or accurately estimated, a similar method of evaluating public interests is applicable.

SOCIAL BENEFITS

Important social benefits can be obtained if fuel reduction work is used to provide highly productive post-war jobs for men who want and need employment. The extent of such benefits will vary depending upon the unemployment situation at the time work is undertaken. Some will say, "They are impossible to evaluate." Others who have studied the problem in detail, think reasonably reliable monetary values can be assigned. J. M. Clark[1], who made a comprehensive study of this problem, shows how social or "secondary labor" benefits can amount to as much as 100 per cent of Government relief expenditures. He explains, however, that the secondary benefits decrease with an increase in the proportion of labor outlay to total expenditures. Considering this, Forest Service economists believe 50 percent of the total expenditures can well be charged to the social benefits derived from work such as fuel reduction where a high proportion of expenditures goes direct to labor.

There are economists who believe the social benefits from federal expenditures designed to prevent unemployment are equal to the amount of relief that would otherwise have to be paid to the unemployed. Arthur C. Bunce indicates a preference for this method in his book, "Economics of Soil Conservation." He believes that the net federal cost of unemployment labor is the wages paid *less* the relief costs avoided. The difficulty here, of course, is in estimating the "relief costs avoided."

The additional employment stimulated within the timber industry by logging and milling dead wood from fuel reduction areas also has a social benefit because it helps to avoid the need for relief. Several difficulties of measurement are yet to be solved, however, before this can be evaluated.

Fuel reduction can benefit society indirectly but very materially by reducing tax losses and by helping to stabilize purchasing power. Federal subsidies and costs for relief, roads, schools, etc., eventually increase when the tax income of local governments is seriously decreased and wage earnings are reduced as a result of timber depletion. There are counties in this region where this is evident. But the specific effects are not well known and are only just now being explored by research. Probably several years' study will be required before they can be accurately expressed in monetary terms.

Much investigation and study is needed in regard to the social influences of forests and forest fires. The subject is not only wide open for discussion but needs it. This office will be glad to receive any comments, criticisms, or suggestions if sociologists will begin to take a sincere interest in the subject. Such correspondence should be addressed to the Director, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.

CONCLUSION

The lack of factual information and specific knowledge regarding fire influences and the techniques of relative social and economic appraisals is a handicap to the development of sound principles of fuel reduction. Estimating and theorizing may have to be relied on more than is desirable. But if the work is done systematically, cautiously, and prudently, the guides that are developed should produce *much* better results than can be obtained by relying on the hurried judgments of many different administrators. The problems of fuel reduction are so complex that busy administrative men can do little more than guess, and such guesses are an obviously inadequate basis for guiding the expenditures of millions of dollars for post-war work.

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[1] Clark, J. M. Economics of Planning Public Works. A study made for the National Planning Board of the Federal Emergency Administration of Public Works. U. S. Government Printing Office. 1935.

WARTIME ACTIVITIES AND PROGRAMS IN NORTHWEST EDUCATIONAL INSTITUTIONS

The following brief outline of wartime activities in educational institutions of the Northwest presents but a glimpse of the tremendous effort in the education of scientifically trained armed services personnel which engages virtually all such schools today. This region may justly be proud of the record so briefly indicated in these items. It has been impossible to include in this issue similar news from several other institutions, due to space limitations. This material, and notes concerning wartime activities of faculty members on leave of absence in northwest educational institutions is a continuation from the last issue.

UNIVERSITY OF IDAHO

Special Wartime Services and Programs

Since May 1942, a part of the University of Idaho campus has been taken over by the Navy and operated as a Radio Training School. Continually since then between 600 and 800 sailors have been on the campus. During the two years this school has been in operation, several thousand Navy radio operators have been trained.

Since early April 1943 the University has had an Army training unit. Its first task was to screen and classify inductees and to recommend the fields in which they should receive specialized training. Later the University was asked to give basic and advanced training in civil, electrical, and mechanical engineering, and in languages. During the course of the language training, nine different tongues, Polish, Czech, Greek, Norwegian, Italian, French, German, Spanish, and Russian, have been spoken in organized groups on the campus. In response to military needs, the University has expanaded its offerings in Russian. The size of the Army unit has ranged from 600 to 900 men.

For three years a pre-flight training program was operated by the College of Engineering. Approximately 150 individuals were started on their way to become commercial, bomber, or fighter pilots. The College of Engineering conducted a special class in engineering drawing to train women for jobs in the drafting rooms of the Boeing plant at Seattle. Sixteen Idaho-trained women now are at work there.

The Department of Agricultural Engineering, in cooperation with the State Department of Vocational Education, conducted a series of vocational training courses in gas and electric welding, blacksmithing, sheet metal work, tractor and motor repair. Between 500 and 600 men so trained in the University's Agricultural Engineering shops are now engaged in war industries. This department also carried on an intensive 3-week course for high school teachers of vocational agriculture and at present is supervising war training classes in over a dozen centers in northern Idaho. In cooperation with the U. S. Office of Education, the College of Engineering has conducted courses in radio, mechanical and electrical engineering, drafting, aerial and bombardment protection, and industrial safety engineering. Some of these courses have been conducted at Boise, Twin Falls, Lewiston, Nampa, and Pocatello.

The University has gone on a year-round wartime basis by adding a 12-week Summer Term. This enables civilian students to speed up their college education and get a degree in about a year less than normal time. Sensing the plight of high school boys and girls who were forced to quit school and go into service, work on the farm or in war plants, the Division of Non-Resident Instruction has instituted a series of 36 high school courses in 7 basic fields—Mathematics, History and Government, Science, Business, English, Sociology, and Language—so they can keep up their studies by mail and be in a better position to resume regular classroom work when peace comes. Four pre-in-

duction courses are being given by the College of Engineering to aid youths below draft age to prepare for technical military duties. Correspondence courses also are being provided for men and women in the services.

Essential information for prospectors, mine operators, and others participating in the intensive search for war minerals in the state were contained in a series of 17 information leaflets issued by the Idaho Bureau of Mines and Geology, of which Dean A. W. Fahrenwald, Mines, is director. Fourteen of the leaflets were written by Joseph Newton, Associate Professor of Metallurgy, two by Lewis Prater, Assistant Metallurgist, and one by Dean Fahrenwald. The leaflets were prepared to meet the large and constant demand for information on the wide range of minerals and mineral products which are playing such an important role in America's war program.

Perhaps the largest wartime assignment handed any division of the University is that being carried by the College of Agriculture. This division is the focal point in the important "Food Production for War" program. The entire work of the College of Agriculture, from research at the Home station and branch stations to that of the extension staff, fixed specialists and county agents, has been revised to a war basis.

One of the important contributions of the College of Agriculture has been the publication of a series of 36 war circulars. Each is a 4-page popular publication filled with timely and practical information on some phase of food production. The series covers practical matters such as how to make farm machinery last longer, substituting home-grown feeds for imported supplies which are not as plentiful as in peacetime, increasing production of essential products, labor-saving ideas for the farm and home, new war crops for the state, new ideas in food preservation and conservation, and farm fire defense.

Over 150 projects are investigated in the Home Station at Moscow, and in branch stations at Sandpoint, Caldwell, Aberdeen, Parma, and Tetonia. Field trials also are conducted at various temporary field stations. Investigations include studies involving the vitamin content and nutritive value of butter, milk, peas, potatoes, pork, and lamb, vegetable seed production problems, wartime poultry rations, control of plant diseases, insect pests, and weeds, application of mechanized farm equipment for Idaho farms, and many others. Cooperative investigations with various federal, state and private agencies also are conducted. These include, for example, wireworm and pea weevil control in cooperation with the Bureau of Entomology and Plant Quarantine, and vegetable seed production, weed control, grain improvement, plant disease survey, soil and irrigation study and bean improvement study in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture.

In addition to doing the many jobs of the moment, the University is looking ahead to post-war years. The School of Business Administration faculty is cooperating with the Idaho State Planning Board in its study of the postwar economic situation in Idaho. Dean Ralph H. Farmer is aiding in a survey of postwar projects involving expenditures by local governmental units.

Several disabled veterans of World War II already are enrolled in the University and the institution is developing special and practical courses for the large numbers certain to come in the next several years.

A committee on academic adjustment is working on the important assignment of making long-range plans to meet the vital educational problems and adjustments which must be made prior to the post-war period. Members of this important committee are: Dean Pendleton Howard, College of Law, Chairman; Dean T. S. Kerr, College of Letters and Science; Dean D. S. Jeffers, School of Forestry; Professor Ralph D. Russell, School of Education; Professor L. C. Cady, Head of the Department of Chemistry; Professor Hobart Beresford, Head of the Department of Agricultural Engi-

neering, and Professor Gerhard A. Reidesel, Acting Head of the Department of Civil Engineering.

Wartime Activities of Science

Faculty Members

Dr. L. C. Cady and Dr. W. H. Cone, Chemistry, were engaged in research on the melting and casting properties of explosives until this work was centralized in special laboratories in the East.

Dean A. W. Fahrenwald, Mines, is engaged in important research to improve the economics of ore dressing by flotation. That his work may result in reducing the power required by 25 to 50 per cent is now forecast.

Paul K. Hudson, Electrical Engineering, has made important contributions in the field of radio engineering. One of his articles, "Modulation Waves," originally appearing in COMMUNICATIONS, has been reprinted in the civilian training section of the Army Signal Corps handbook for use in its classes in radio engineering.

Dr. J. D. Forrester, Mines, has been working in cooperation with the U. S. Geological Survey, on a geologic field map of Idaho.

Dr. W. W. Staley, Mines, spent considerable time in the field last summer working with mine operators, prospectors, and local business groups interested in the development of Idaho mineral resources.

Roy Kayler, Machine Shop Foreman, is making machine parts for ships.

Dean J. F. Messenger, Education, wrote an article on "Post-War Education," appearing in SCHOOL AND SOCIETY, which attracted national attention and brought him a large number of complimentary letters.

Dean T. S. Kerr of the College of Letters and Science, has just been advised by the publisher of his book, "Business Law, Principles, and Cases," that the Armed Forces Institute at Madison, Wisconsin, has taken 1,500 copies for use in training soldiers for foreign service to follow the army of occupation.

Approximately 50 members of the University staff either are in military service or some governmental activity directly related to the war program.

REED COLLEGE

Special Wartime Services and Programs

From February 15, 1943, to February 12, 1944, over 200 Army Air Force trainees were given the Basic Premeteorology curriculum at Reed College, concentrating upon mathematics and physics.

Wartime Activities of Science

Faculty Members

The academic Director of the Basic Premeteorology course was Dr. A. A. Knowlton, head of the Physics Department. Dr. F. L. Griffin, head of the Mathematics Department, also devoted his full time to instruction in this program.

Recent changes in personnel of the science faculty: Dr. L. E. Griffin retired from active teaching at the conclusion of the last academic year and has been given the rank of Professor of Biology, emeritus, by the Board of Regents. In the fall of 1942, Dr. Ralph W. Macy, formerly of St. Thomas College, joined the faculty as Professor of Biology, becoming head of the Biology Department upon the retirement of Dr. Griffin. Dr. Charles Reed joined the faculty of the Biology Department in the fall of 1943.

Dr. Arthur F. Scott, head of the Chemistry Department, assumed the duties of Acting President of the College in February 1942. His teaching duties were taken over by Dr. Frank H. Hurley, who joined the Chemistry staff in the fall of 1942. Since last June, Dr. Hurley has been serving as Acting Dean of Men in addition to his work as Assistant Professor of Chemistry.

WARTIME ACTIVITIES OF FACULTY MEMBERS ON LEAVE OF ABSENCE FROM NORTHWEST EDUATIONAL INSTITUTIONS

EASTERN OREGON COLLEGE OF EDUCATION

One faculty member serving in the Navy.

EASTERN WASHINGTON COLLEGE OF EDUCATION

Raymond F. Bell, Inst. in Science and Mathematics; instructing mathematics in the Navy.

Dr. J. L. Botsford, Asst. Prof. of Mathematics; teaching physics to air cadets at the Central Washington College.

Dr. R. K. Dahlstrom, Asst. Prof. of Physical Sciences and Mathematics; employed by the Federal Government in confidential physics research work at Washington, D. C.

Dr. O. W. Freeman, Head, Division of Physical Sciences and Mathematics; teaching geography to air cadets at Indiana University.

Andrew E. McArthy, Inst. in Physical Sciences and Mathematics; teaching in the war program at the University of Kansas.

Robert W. Rogers, Inst. in Biology; engaged in radar work with the Navy.

MONTANA SCHOOL OF MINES

Members of the faculty on leave are with the Bureau of Naval Ordnance, with the Office of Economic Warfare, and with various air plants.

MONTANA STATE COLLEGE

William E. Booth, Asst. Prof. of Botany; stationed with the 54th Medical Training Battalion, 4th Platoon, Camp Barkeley, Texas.

John Bowers, Asst. Prof. of Agricultural Economics; a private in the Army with the Tank Corps Division.

Glenn Craig, Asst. Prof. of Economics and Sociology; living at 2900 Erie Street, S.E., Apartment B-63, Washington, D. C.; working for the War Food Administration. His work has to do with food distribution and production goals.

T. Vincent Dolan, Asst. Prof. of Physical Education; served as a Field Representative for the Red Cross from June, 1941, to August, 1943, at which time he returned to the College. While working for the Red Cross he was in charge of First Aid in the district covering the states of Arizona, Texas, and New Mexico.

Schubert S. Dyche, Head, Physical Education; left in September, 1942, to become Club Director for the Red Cross with headquarters in London. Later, he became Director of District of Service Clubs and at the present is with the Financial Division of Headquarters Office in London.

H. G. Halcrow, Asst. Prof. of Agricultural Economics; serving as an ensign in the Navy stationed at the Advanced Base Personnel Depot, San Bruno, California.

David Hawes, Inst. in English; lieutenant with the Intelligence Division of the Army Air Corps, awaiting overseas duty.

Charles Herring, Inst. in English; first lieutenant in the Army stationed in London. His address is Headquarters, E.T.O., APO 87, c/o Postmaster, New York, New York.

O. B. Hitchock, Asst. Prof. of Entomology and Asst. State Entomologist; serving as a lieutenant (j.g.) with the Navy. Until his recent transfer to St. Thomas, Virgin Island, he was stationed in Florida doing mosquito control work.

H. G. Hollands, Prof. of Agricultural Economics and Sociology; serving as Milk Marketing Agent for control boards at Spokane, Portland, and Seattle. His address is Market Agent, 1223 Smith Tower, Seattle 4, Washington.

Roy Huffman, Inst. of Agricultural Economics; assigned as payroll officer in the Navy.

Thelma Laird, Asst. Prof. of Modern Languages; serving as a lieutenant in the WAC's stationed at the Army Air Corps base in El Paso, Texas.

Charles Nagel, Asst. Prof. of Physical Education; private in the Army at present stationed at Fort Mead, Maryland, awaiting overseas duty.

O. A. Parsons, Assoc. Prof. of Economics and Sociology; lieutenant in the Army Air Corps, teaching history to the air corps cadets. His present address is 202

East 9th, Santa Ana, California.

D. J. Pletsch, Asst. Prof. of Entomology; serving as a lieutenant in the Department of Sanitation, O.C.S., Camp Barkeley, Texas.

MONTANA STATE UNIVERSITY

Charles Deiss, Prof. of Geology; doing war work with the United States Geological Survey.

Harry Turney-High, Prof. of Anthropology and Sociology; stationed with the Army in England.

Bert R. Sappenfield, Inst. in Psychology; in active service with the Army.

OREGON STATE COLLEGE

Dr. James J. Brady, in charge of a group working at the eleitronic division of the Radiation Laboratory at the Massachusetts Institute of Technology.

Dr. J. S. Butts, Prof. of Biochemistry; holds the rank of major in the Medical Corps of the Army Air Force. He has served variously as nutrition officer in London with the 8th Air Force and in research assignments in this country, chiefly out of Washington, D. C.

Dr. W. E. Caldwell, Assoc. Prof. of Chemistry; serving as a lieutenant colonel in the Chemical Warfare Service at Edgewood Arsenal where he is Director of the Protection Division of the Chemical Warfare School.

W. J. Chamberlin, Entomology; a major in the Army Air Corps.

Dr. Corruccini, Inst. in Physical Chemistry; engaged in war research with a government agency.

J. E. Davis, Entomology; a lieutenant in the Army Air Corps.

Dr. Clifford Grobstein, Zoology; lieutenant in the Army Air Forces engaged in research and in teaching aviation physiology at Clovis, New Mexico.

H. P. Hansen, Asst. Prof. of Botany; on leave 1943-44 under a Guggenheim Fellowship doing research and writing on Post Glacial Forest Successions in the Pacific Northwest. This work is based on pollen analysis from bogs.

J. William Kirkham, Inst. in Mathematics; lieutenant in U.S.N.R., instructing Naval Cadets at the Navy Pre-Flight School at Del Monte, California.

W. E. Lawrence, Assoc. Prof. of Plant Ecology; on leave 1942-43 doing research on an ecological problem at Stanford with the Carnegie Foundation.

R. L. Post, Entomology; serving as a seaman 1/c in the Coast Guard.

Dr. Jack G. Roof, Asst. Prof. of Chemistry; was participating in confidential research at the Technological Institute, Northwestern University. He has now been sent overseas, though still a civilian, to carry out the practical application of his research.

L. F. Roth, Inst. in Botany; enlisted in the Navy in the spring of 1942. After indoctrination at Great Lakes, served as pharmacist mate, Norfolk, Virginia; later sent with unit to business school at Harvard. Graduated as an ensign. Now serving as paymaster on U.S.S. Card.

Dr. Allen B. Scott, Inst. in Chemistry; first lieutenant, serving with Field Artillery, 70th Division, Camp Adair, Oregon.

Andrew Sobczyk, Inst. in Mathematics; employed at M.I.T., Cambridge, Massachusetts, doing experimental work in radar.

Dr. Edwin A. Yunker, A division head in the Radio Laboratory at Harvard University.

Dr. L. E. West, Asst. Prof. of Chemistry; engaged in metallurgical research at the University of Chicago.

REED COLLEGE

Dr. R. M. Lichtenstein, Physics; enlisted in the Army, stationed at Camp Crowder, Missouri.

Dr. Marcus O'Day, Physics; participating in a research program at one of the radiation laboratories at Massachusetts Institute of Technology.

STATE COLLEGE OF WASHINGTON

David E. Aldrich, Inst. in Mechanical Engineering; serving in the Army.

Ammon Andes, Asst. Prof. of Mechanical Engineering; working in a commercial airplane plant.

Sylvia Antilla, Asst. Extension Agent in Home Economics, Skagit County; enlisted in the WAC's.

Hilmer Axling, Asst. County Agent, Spokane County; serving in the Army.

Helmer W. Basso, County Agent, Wahkiakum County; serving in the Army.

Joseph B. Birdsell, Inst. in Anthropology and Archeology; instructing in the Army Air Corps in Texas.

Anderson H. Calvert, Extension Editor; serving in the Navy.

Charles D. Campbell, Asst. Prof. of Geology; working with a strategic mineral staff.

Harry L. Cole, Assoc. Prof. of Chemistry; serving in the Army.

Donald R. Cordy, Inst. in Veterinary Pathology; serving in the Army.

Lee J. Cronbach, Asst. Prof. of Psychology; Associate Psychologist serving on the National Defense Research Council.

William M. Duncan, Asst. Veterinarian, Western Washington Experiment Station; serving in the Army.

Mary Ann Faletto, Asst. Extension Agent in Home Economics, Thurston County; a WAVE enlistment.

Richard H. Fowler, Asst. in Soil Survey; serving in the Army.

L. I. Gilbertson, Asst. Prof. of Chemistry; participating in research work for war effort at Columbia University.

William G. Gnaedinger, Head, Bureau of Visual Teaching; a Navy enlistment.

Hilton P. Goss, Inst. in History and Political Science; serving in the Army.

Maynard S. Grunder, Agronomist, Western Washington Experiment Station; serving in the Army.

Gale G. Gurtle, Asst. Extension Agent in Agriculture, Whatcom County; serving in the Army.

Edward A. Heinemann, Asst. Extension Agent, Lincoln County; serving in the Army.

Sidney G. Hacker, Asst. Prof. of Mathematics; serving in the Navy.

A. William Hajjar, Inst. in Architectural Engineering; serving in the Navy.

R. B. Heflebower, Dean, School of Business Administration; in Washington, D. C., employed in the Office of Price Administration.

George E. Hudson, Asst. Prof. of Zoology; serving in the Army.

David D. Jackson, Asst. County Agent, Clark County; serving in the Navy.

Vincent E. Johnson, Asst. County Agent, Clark County; serving in the Navy.

W. M. Landeen, Assoc. Prof. of History and Political Science; serving in the Army, (Military Government).

Paul H. Landis, Dean, Graduate School; served six months with the U.S. D.A., now returned to staff.

Hugo L. Libby, Inst. in Electrical Engineering; serving in the Army.

Howard Mathany, Inst. in Mathematics; serving in the Navy.

Cecil F. McClary, Asst. Poultryman, Western Washington Experiment Station; serving in the Army.

Arnold O. Ness, Asst. In Soil Survey; serving in the Army.

Marion Ownby, Asst. Prof. of Botany; botanist for Office of Economic Warfare, now returned to staff.

Edgar Reif, County Agent, Ferry County; serving in the Army.

June Roberts, Investigator in Farm Electricity; serving with the Navy.

Rae Russell, Extension Nutritionist; served as Regional Nutritionist for the Federal Security Agency, Washington, D. C.; returned from leave July, 1943.

Ray Schatz, Asst. Prof. of Metallurgy; serving with the Army in Alaska.

Ned Shorey, Asst. Extension Agent, Kittitas County; serving in the Army.

Orlie W. Smith, Asst. Extension Agent, Pierce County; serving in the Army.

Carl G. Stock, Asst. County Agent, Whatcom County; serving in the Army.

James W. Stubbs, Extension Forester; serving in the Army.

Rayburn D. Tousley, Asst. Prof. in Marketing; was on leave serving with the Office of Price Administration.

Leonard Vanderhoop, Asst. Herdsman, Animal Husbandry; serving in the Army.

J. R. Vatnsdal, Asst. Prof. of Mathematics; serving in the Army.

Fred R. Yoder, Head, Department of Sociology; recently returned from service with the Army Air Corps.

Royal Weller, Asst. Prof. of Mechanical Engineering; doing research with the Navy.

L. C. Wheeting, Research Prof. in Soils; serving in the Army.

John F. Williams, Jr., Asst. Prof. of Mining and Metallurgy; serving in the Navy.

Clarence Zener, Assoc. Prof. of Physics; engaged in research work at the Army Arsenal, Watertown, Massachusetts.

UNIVERSITY OF IDAHO

Vada Allen, Botany; working in the drafting and blueprint department at the Kaiser yards, Vancouver, Washington.

Dr. Earle Blodgett, Plant Pathology, engaged in an emergency plant disease survey. The purpose of this survey is to locate serious outbreaks of plant diseases and to guard against introduction of plant diseases from other countries, thus aiding in the national food production program.

Dr. W. R. Boyer, Education; applying his knowledge of psychology in the Army induction field.

J. E. Buchanan, Dean, Engineering; instructing in a school for army engineers, Fort Belvoir, Maryland.

Earl W. Carlsen, Asst. Prof.; engaged in making an analysis of the prospective postwar employment situation in the state.*

Dr. V. A. Cherrington, Bacteriology; first lieutenant in the Sanitary Corps stationed in the bacteriology laboratories at Carmel, California.

Arthur Davidson, Engineering; instructing at the army engineers' school, Fort Belvoir, Maryland.

Dr. John Ehrlich, Forestry; temporarily engaged in the mycological phase of the penicillin research project recently established by the War Production Board at the University of Minnesota.

R. A. Fisher, Entomology; lieutenant in the Medical Corps stationed in a laboratory in Italy.

William E. Folz, Business; serving with the U. S. Budget Bureau.

F. C. Fountaine, Dairy Husbandry; doing research work on the nutritive value of butterfat at the University of Minnesota.

D. L. Fourt, Dairy Husbandry; supervising the emergency farm labor program in Idaho.

Dr. Gerhardt Friedlander, Chemistry; engaged in essential war research. At present he is doing physio-chemical research of a highly secret nature in a government laboratory in New Mexico.

Dorothy Hale, Infirmary Technician; serving in the Army Medical Corps.

Stanley Hall, Mechanical Engineering; working in the engineering department of one of the large western aircraft companies.

Dr. G. W. Hammar, Physics; engaged in secret research for the National Defense Research Council.

Arthur H. Harding, Law; lieutenant colonel engaged in legal activities for the Army.

Frank G. Hinman, USDA Asst. Entomologist; serving as a technician at a field hospital in Ireland.

John W. Howard, lieutenant colonel inspecting contracts for Army supplies in the West.

Allen S. Jansen, Engineering; lieutenant in the Seabees stationed in Australia, constructing naval bases.

James Kalbus, Purchasing Agent; major in the Army Air Corps serving as a finance officer in England.

Percy A. LaSalle, Chemistry; serving as a major in the Army at Edgewood arsenal.

H. C. Manis, Entomology; employed as flight instructor at Thunderbird Field, Arizona.

Elmer Million, Law; working with a special war policies unit in the Department of Justice.

William C. Moore, Business; serving with the War Relocation Authority at Boise. His duties are to find industrial employment for Japanese citizens who have been removed from the Pacific area.

Dr. Harry Owens, Chemistry; working on the staff of the Western Regional Laboratory of the U. S. Department of Agriculture, Albany, California. Among other projects. Dr. Owens has been attempting to find a substitute for agar-agar. The supply of this material has been sharply curtailed by the Japs.

Royale K. Pierson, Extension Forestr; assistant supervisor of the emergency farm labor program in Idaho.

Dr. Phimister J. Proctor, Forestry; a major in the Army's Materiel Command, Wright Field, Dayton, Ohio. He inspects the inspectors and checks troubles in airplane plants using wood, all over the United States.

---

*Arrangements are almost complete for Dean Ralph H. Farmer and Carlsen to make an economic analysis of the Coeur d'Alene area along the lines of the study of Albert Lea, Minnesota area made by the U. S. Chamber of Commerce.

William Schroeder, Mechanical Engineering; working in the engineering department of a large western aircraft company.

Walter Warstler, Mechanical Engineering; employed in the engineering department of one of the large western aircraft companies.

W. J. Wilde, Business; Idaho State Price Officer with the Office of Price Administration.

L. Jannette Wirt, Women's Physical Education; serving as a USO recreational director.

Herbert J. Wunderlich, Dean of Men; in special training for duty with the Naval forces of occupation.

Dr. V. A. Young, Forestry; serving with the Soil Conservation Service at Escondido, California. His job is to help increase range productivity for cattle and sheep in that locality.

Six men from the Physical Education department, *George W. Greene,* Head, *Guy P. Wicks, Glenn Jacoby, Louis August, Walter J. Price* and *Leon Green* are in the service handling administrative or physical fitness assignments.

UNIVERSITY OF OREGON*

Dr. H. G. Barnett, Asst. Prof. of Anthropology; serving in Washington with the Ethnogeographic Board.

Dr. L. F. Beck, Assoc. Prof. of Psychology; employed by the Army as a civilian expert in connection with instructional films.

Dr. A. E. Caswell, Head, Department of Physics, engaged in research in the radiation laboratories at the Massachusetts Institute of Technology.

Dr. C. W. Clancy, Inst. in Zoology; lieutenant in the Army Air Corps assigned to research work.

Dr. K. S. Ghent, Asst. Prof. of Mathematics; employed by the Navy as a civilian physicist.

Dr. T. S. Peterson, Asst. Prof. of Mathematics; working as a civilian physicist for the Navy.

Dr. C. H. Secoy, Asst. Prof. of Chemistry; doing special chemical war research at Columbia University.

Dr. L. W. Staples, Asst. Prof. of Geology; serving as a consulting geologist for strategically vital quicksilver mines.

Dr. M. E. Starr, Inst. in Physics; engaged in research in the radiation labcratories at the Massachusetts Institute of Technology.

UNIVERSITY OF WASHINGTON

Willoughby M. Cady, Asst. Prof. of Physics; doing national defense research work at the Radiation Laboratory at M. I. T.

Phil E. Church, Assoc. Prof. of Geography; participating in research work at the Institute of Meteorology, University of Chicago.

Frederick Crescitelli, Inst. in Physiology; visiting Asst. Prof. of Physiology in the Division of Aviation Medicine at the University of Southern California Medical School; doing research work on contract from the Office of Scientific Research and Development.

Bernard S. Henry, Prof. of Bacteriology; captain in the Army stationed with the Ninth Service Command Laboratory at ort Lewis, Washington.

Ray W. Kenworthy, Asst. Prof. of Physics; captain in the Army attached to Edgewood Arsenal, Maryland.

Thomas G. Thompson, lieutenant colonel in the Army stationed at Edgewood Arsenal, Maryland.

WHITMAN COLLEGE

One instructor in physics is now in England on a secret mission for the government.

WHITWORTH COLLEGE

Dr. Paul V. Gustafson, a member of the armed forces stationed at the Medical College, Chicago, Illinois.

Benjamin C. Neustel, employed as an ammunition inspector on the Pacific Coast.

---

*More than 50 members of the Medical School faculty are in active Army service with the 46th General Hospital, the University of Oregon Medical School Army Medical Unit. Considerably more than that number are in other units of the Army and Navy medical service.

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COMMERCIAL PRINTING DEPARTMENT

NORTHWEST SCIENCE

August, 1944

Vol. XVIII, No. 3

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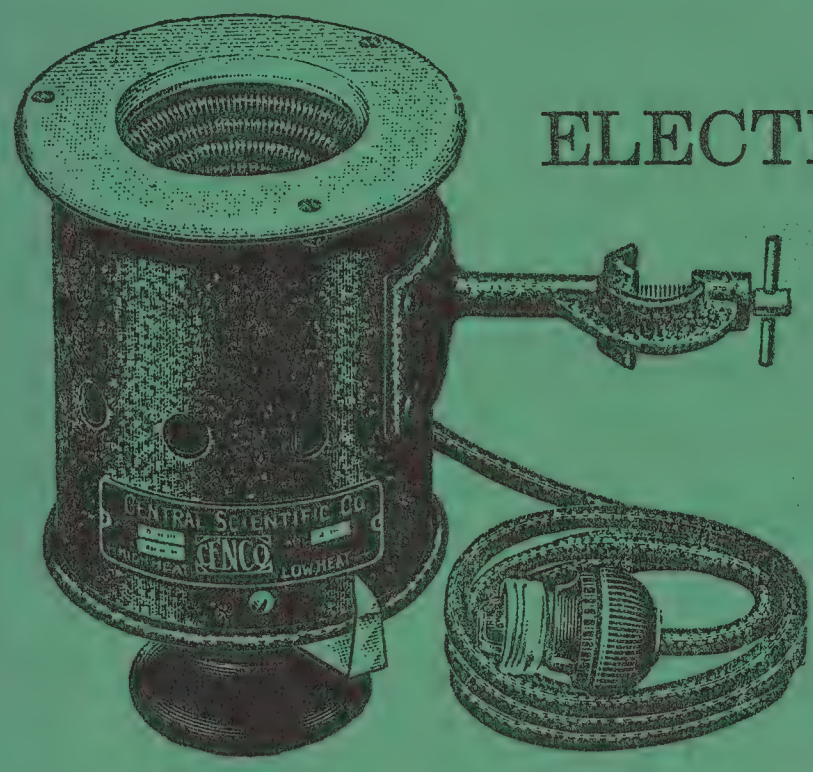

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NORTHWEST SCIENCE

Volume XVIII, Number 3

1944

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Published quarterly by the Northwest Scientific Association

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL. XVIII, NO. 3 AUGUST, 1944

Published December 20, 1944

Editor, W. R. HATCH, State College of Washington

To Our Readers:

With this issue, NORTHWEST SCIENCE embarks upon a study of the military training programs with which many institutions in the Northwest have been preoccupied during the last two years. These programs accomplished what they were intended to accomplish—they helped train a citizen's army, but so much of the nation's best man power and brain power and so much of its resources went into these programs it is to be hoped that we can discover in them practices and methods which may help to educate our citizens for peace as well as war. But it is not enough to hope. The colleges and universities who were privileged to serve in these programs have now the obligation to evaluate their experience. Such an evaluation, however, must be made soon before the faculties assembled to instruct in the programs are dispersed and time dulls the memories of those who participated.

In this study, however, we must be critical and as objective as possible for it is quite as important for us to know which practices and methods cannot be adapted to civilian education as to discover those that may have application.

It was considerations such as these that prompted NORTHWEST SCIENCE to initiate and now to coordinate a study of the military training programs in this region. In this project the following schools were invited to participate: Central Washington College of Education, Western Washington College of Education, Montana State College, Montana State University, Oregon State College, Reed College, University of Idaho, University of Oregon, Washington State College. and Whitman College. Of these ten institutions, four, the Central Washington College of Education, the University of Idaho, Washington State College, and Whitman College have already evaluated their experience and are now in the process of preparing reports for NORTHWEST SCIENCE. It is hoped that the other institutions will also cooperate in the study. Comments organized in the manner of this symposium or submitted individually in letters to the editor are solicited from any other institutions having experience with a similar program.

The methods evolved in the Washington State College study, reported in this issue, have been adopted by all participating institutions. Since these methods are described in the introduction to the Washington State College article, they need not be discussed here. It might be noted, however, that every effort has been made to enlist the most qualified persons on the several campuses and to handle all data as objectively as possible.

Anyone wishing to subscribe to NORTHWEST SCIENCE ($1.00) or who are interested in obtaining reprints of articles appearing in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

THE EDITOR.

GLACIATION AND SOME HUMAN RELATIONSHIPS AT LAKE CHELAN

OTIS W. FREEMAN
*Indiana University**

Lake Chelan, a fiord-like body of water, extends for sixty miles from the Columbia Valley in a northwest direction into the heart of the snow and ice fields of the northern Cascade Mountains of Washington, and is one of the deepest and in several respects most remarkable lakes in the world. The surface of the lake at highwater stands 1,110 feet above sea level while soundings show that the bottom of the lake off Point No Point is 400 feet below sea level, making the entire official depth 1,510 feet, with unofficial soundings that claim depths as great as 1,600 feet. Lake Chelan is the second deepest lake in North America, exceeded only by Crater Lake, and only a few other lakes have greater depth elsewhere in the world. The lake at its narrowest is half a mile wide and averages only one to two miles across throughout its length. Half way up the lake, Pyramid Mountain rises more than 7,000 feet from the surface of the water within a distance of three miles and 8,500 from the bottom of the lake, making the canyon occupied by the lake one of the steepest and deepest in North America.

Lake Chelan originated as a result of a combination of glacial erosion throughout the upper and middle parts of the lake and deposition at the outlet of the lake. The lower lake is quite shallow up to the Narrows at Wapato Point. Beyond that place the floor of the lake steadily deepens until a maximum depth is reached about half way up the lake. From there on, the lake bottom shoals but more gradually than in the lower lake. Pre-glacial Chelan Valley had a length of about 75 miles represented now by Lake Chelan and the Stehekin River.

The bedrock of the Chelan-Stehekin part of the Cascade Range consists mostly of granite with which also occur other introusive and metamorphic rocks believed to be of Mesozoic age or older. The basalt flows of the Columbia Plateau do not occur in the drainage basin of Lake Chelan. The bedrock is hard but generally well jointed and the presence of these cracks doubtless facilitated erosion by the actively moving ice masses. Since the glaciers have melted away, the joints in the rocks have been enlarged by weathering and erosion by rain water and are becoming the site of the newly developing stream valleys.

The mountain slopes above Lake Chelan are ground smooth, gouged and polished by glacial action up to elevations of 4,000 feet above the water surface. Adding the depth of the lake, a thickness of over one mile is indicated for the Chelan Glacier. Lower ridges and summits like Domke Mountain were overridden by the ice and are well rounded. The rounded features called roche moutonee are common. The level reached by the main glacier can easily be determined on the mountains by the occurrence of sharp pinnacles and other features that result from ordinary weathering without erosion by moving ice. Nearly all tributary valleys into Lake Chelan head in cirques and the headward erosion by the side glaciers in them has resulted in numerous peaks of the pyramid or Matterhorn type. Rock-basin lakes occur in the cirques and small remnant glaciers still occupy some of them. Since the bed of Lake Chelan and its extension, Stehekin River, together with numerous tributaries were once filled by a vast glacial system over 4,000 feet thick, the major valleys were deepened and broadened giving them the typical U shape associated with glaciation and the ends of many tributary canyons were eroded, thereby forming "hanging valleys." Numerous waterfalls like 300-foot Rainbow Falls near Stehekin and Domke Falls near Lucerne drop from the hanging canyons to the lake or Stehekin Valley floor.

At the head of the lake the more important collecting tributary valleys

*On leave from Eastern Washington College of Education.

were Agness Creek, Park Creek, Horseshoe Basin, and Bridge Creek. Below the head of the lake, tributaries are unimportant except Railroad Creek that enters the lake from the west. The collecting area at the head of Lake Chelan is large for a mountain glacier, which explains the great thickness (over 4,000 feet) and length (75 miles) that it extended from the crest of the Cascades northeastward almost to the Columbia River.

Ten miles from the head of the lake the valley of Railroad Creek formerly joined the Chelan Valley on a course between Domke Mountain and Emerald Peak, with Domke Lake occupying a portion of this former valley. When the Railroad Creek Glacier occupied the valley at Domke Lake, it lay in the shadow of Emerald Peak and as it wasted away, much of the melt water was carried to Lake Chelan by a spillway that developed north of Domke Mountain, probably after the divide had been lowered and narrowed by glacial erosion. The torrent of melt water eroded the spillway deeper than the Domke Lake outlet and lower Railroad Creek now occupies the resulting narrow gorge, while upper Railroad Creek would fit in more naturally with the original Domke Lake Valley. Since Domke Lake lies nearly 1,200 feet above the level of Lake Chelan and the lake at this point is nearly 1,200 feet deep, there is indicated an apparent deepening of Lake Chelan by glacial erosion of around 2,000 feet. It seems remarkable that the bottom of the lake could be excavated from the solid granite to depths of over 400 feet below sea level, but such seems beyond question to have occurred.

The largest side feeder to the huge glacier that moved down the valley now occupied by Lake Chelan, came from Railroad Creek. Today, only tiny remnants of this great glacier are left. One of these is Lyman Glacier that covers about three-fourths of a square mile at the headwaters of Railroad Creek. The valley of Railroad Creek has a length of about twenty-five miles. The stream itself issues from Lyman Lake at an elevation of 5,525 feet, and on its journey to Lake Chelan descends more than 4,400 feet, passing through the mining center of Holden. For the past fifteen years it has been regularly visited the last of September by representatives of the Washington Water Power Company who have established a bench mark from which the recession of the ice front has been measured. During this time the glacier has receded an average of nearly 60 feet per year and has also lost an unknown amount in thickness by melting and evaporation. While the positions of the fronts of other remnant glaciers in the Lake Chelan section of the Cascades has not been accurately measured, their general appearance indicates a retreat at approximately the same rate as that of the Lyman Glacier. The rate of recession of the glaciers is of importance to the power company as in addition to rainfall the streams that feed Lake Chelan obtain water from melting ice which is now tending to disappear.

Chelan Glacier may have extended nearly to the junction of the Columbia Valley but if so, it did not maintain its position long but retreated rather rapidly to a point above Twenty-Five Mile Creek where it maintained itself for a considerable time. While this was happening, the Okanogan lobe of the Cordilleran Ice Sheet invaded the state from Canada and moved southward through the Okanogan Valley and down the Columbia River to beyond the mouth of the Chelan Valley, completely blocking the end of Lake Chelan and by damming up the melt water, created a lake between the Chelan Glacier and the Okanogan-Columbia Valley lobe. For a time the Chelan Valley was invaded by the Columbia glacier up at least to Wapato Point which is proven by finding boulders of Columbia River basalt near Wapato. Since no basalt occurs in the upper Chelan-Stehekin Valley the boulders could only have been brought in by the movement of ice from the Columbia Valley.

Two former outlets and numerous terraces of this high level glacial lake exist between the foot of Lake Chelan and Twenty-Five Mile Creek. The upper spillway through Navarre Coulee (elevation 1663 feet) operated first and its floor determined the highest level of

Glacial Lake Chelan which existed for a sufficient time for an extensive terrace to develop on the hillsides above Lakeside and Chelan. The recession of the Okanogan-Columbia Valley glacier towards the city of Chelan from Wapato, uncovered a lower outlet through Knapp Coulee (elevation 1,340 feet) now followed by the highway from Wenatchee to Lakeside. A broad terrace was developed at this lower lake level determined by an outcrop of hard rock on the floor of Knapp Coulee.

With the disappearance of the ice the old outlet of the Chelan River had become completely blocked with debris, mostly fluvial glacial deposits left by the Okanogan-Columbia lobe. A new course for the river was established between the deposits and the south wall of the valley where in post-glacial times the Chelan River excavated a narrow gorge in the granite bedrock through which the stream descends 400 feet in three miles. Another lake terrace corresponds to the original elevation of the stream bed of Chelan River.

Several thousand acres of the terraces formed at the various stages of Glacial Lake Chelan are devoted to fruit orchards (apples, pears, cherries, a few walnuts and apricots) near Chelan, Lakeside, Wapato and Twenty-Five Mile. Water for irrigation is usually pumped from Lake Chelan and Lake Wapato but is supplemented by wells, springs and small streams.

Power is developed from Chelan Gorge in a hydro-electric plant which carries water through a tunnel from Lake Chelan to the generators that have a capacity of 64.400 horsepower. To insure an adequate supply of water, permission was secured from the government to raise the level of Lake Chelan twenty feet by a dam at the lower end. Because of the steepness of the walls of Lake Chelan, little damage was done to the scenic beauty by this development, except to a beach at Lakeside and the hotels and houses on low ground at Lakeside and Stehekin.

Above Twenty-Five Mile Creek the walls of Lake Chelan descend very abruptly into deep water. The soil was removed during the Glacial Period and the granite rock being hard, has weathered but little since. The only land which is level enough for building or possesses even a suggestion of soil is on the torrential fans built out into the lake by some of the larger streams. Resorts have been established in these places, and a small garden, a fruit tree or two, perhaps a cow and chickens, may be seen. The principal resorts and homes on the upper lake are on the torrential fans, locally called bars, at the mouths of Canoe Creek, Meadow Creek, and Fish Creek, on the east side, and Railroad Creek, on the west shore of Lake Chelan. A property at Canoe Creek is interesting in that the house is built of logs floated across the lake and possesses the most northerly grove of English walnuts known to the author, in the United States. The presence of the lake, which is too deep to freeze, prevents frost damage and permits the walnuts to be grown. At the head of the lake, lodges are located at Stehekin on the rocky fan deposited by Purple Creek, and two miles up the Stehekin Valley near Rainbow Falls. The original site of Stehekin was flooded when the lake level was raised for the storage of water power. A Boy Scout Camp and Forest Service Camp are located at the Prince Creek bar. Each of the creeks mentioned has a narrow inner gorge in a broader, more mature valley, the inner gorge being of post-glacial development.

The rocky cliffs of upper Lake Chelan are so steep that no highway has been built above Twenty-Five Mile on the southwest shore and not as far yet on the northeast side. Except for pack horse trails, transportation for freight, mail and passengers to the head of Lake Stehekin, to Lucerne at the mouth of Railroad Creek and various other resorts, is entirely by water. The concentrates from the largest gold-copper mine in the state at Holden up Railroad Creek are put in 5-ton buckets and first hauled by truck to Lucerne and then loaded on barges and towed to Lakeside where trucks move them to the railroad at Chelan Falls for shipment to the Tacoma smelter. The power lines for the mine run along the northeast bank to the narrows and then is suspended for nearly 4,000 feet across

the lake to reach Railroad Creek Canyon and the mine and mill at Holden. Incidentally, the developments at Holden have been so carefully planned that no noticeable injury has resulted to the forest scenery. The tailings are stored instead of being dumped into Railroad Creek so that even the Ash are unaffected.

From Stehekin a highway runs a score of miles up the Stehekin Valley to Bridge Creek and is being extended to serve mining prospects in Horseshoe Basin. A few ranches are scattered along the floodplain of the Stehekin River but farming is confined to hay crops and gardens.

Most of the land tributary to Lake Chelan about Wapato Point is in National Forests in which some lumbering operations are carried on under strict control. Most of the forest cover, however, is of non-commercial grade and most of the region is of more value for hunting, fishing and resorts than as a source of timber. Extensive game preserves help to insure protection of deer, mountain goats, and other animal life. Efforts have been made to create a Cascades National Park that would include the Lake Chelan region and the author feels that from a scenic standpoint the area is worthy of a national park status. However, the Washington State Planning Commission, after careful study, concluded that a multiple use of the region would be better for the state than to form a new park. The Commission felt that the development of new mines, utilization of saw timber, use by tourists, hunters and campers, summer grazing and farming would make the area more useful to the most people than if a park was established.

The writer feels that Lake Chelan is a much neglected scenic attraction. Glaciation accounts for much of the spectacular scenery, which is superior to Tahoe or any other large mountain lake in the United States. Yet Lake Chelan is visited by only a few thousand people annually and only a few hundred of these remain longer than the one-day round trip from Lakeside to Stehekin. If in California, where it would be advertised, I suppose Lake Chelan would entertain tens of thousands of visitors during the season. Sometime this may happen in Washington and the lovely mountain lake that resembles a Norwegian fiord and the best of the Swiss mountain lakes will receive the attention it deserves.

THE MOTION PICTURE: A TOOL FOR THE SCIENCE TEACHER

FRANK F. GOROW
Acting Head, Bureau of Visual Teaching, State College of Washington

The use of most of the so-called "visual aids" as teaching tools comes easily and naturally to science instructors. Textbook illustrations, wall charts, blackboards. bulletin boards, graphs, maps, objects, specimens, models and demonstrations are all commonly and effectively used. Projected pictures, in the form of lantern slides, have long been utilized as an adjunct to the lecture. Lantern slides present but one unnatural element which mitigates against its use in the classroom, that of the darkened room. This factor does not ordinarily limit their usefulness; on the contrary, it often enhances the effectiveness of the pictorial representation.

The motion picture (and specifically the sound film) possesses many attributes which mitigate against its ready acceptance as a teaching tool. It is mechanical in its portrayal of objects and action, and its verbal discussion. It is inflexible in the material portrayed and in its explanation of that material. It is an outsider intruding upon the instructor's domain. As a result, the instructor who uses sound films all too frequently turns over his class to the usurper; if the film proves ineffective as an instructor, the film is blamed. The motion picture alone cannot replace the teacher; nor can any other piece of laboratory equipment. It is the writer's purpose to show that the sound film can be brought to heel—can be made subservient to the instructor's purpose and to his conduct of the class instruction.

Let us consider first the advantages brought to the classroom by the motion picture and the purposes for which films may be used. The motion picture can bring to us the remote in time as well as in distance. Faraway lands, inacessible places and hazardous phenomena can be brought to the classroom. Objects too large to be encompassed by the eye may be reduced in size or selected views portrayed. Objects too small to be seen by the unaided eye may be magnified. The camera may be combined with the telescope, the microscope or other visual instruments. Evanescent phenomena may be permanently recorded for later observation. Slow motion makes possible the analysis of processes too rapid for ordinary observation. "Stop-motion" photography speeds up very slow processes, as the growth of a plant, so that hours may be compressed into seconds. By means of animation (moving diagrams), processes and mechanical actions may be clearly explained and unobservable action represented. Out-of-season phenomena may be viewed at will. In the sound film natural sounds add essential realism in certain instances. A variety of widely dispersed forms of life, of topography, or of phenomena, may be brought together for ready comparison. Explanations do not depend on words alone; showing and explaining are simultaneous in the sound film. All members of the class have a front seat view; they see what the instructor intends them to see. The motion picture extends man's vision, overcoming limitations of space, time and motion. It provides a rapid and vivid summary of phenomena.

The principles of effective use of the motion picture are similar to those governing effective use of the lecture demonstration or other visual lesson. The instructor must know his material; a preview of the film is of paramount importance. The use of the film must be planned to fit into the course outline; this involves careful selection and timing. Advance scheduling of films is necessary if they are borrowed or rented from a film library. Before the class hour the projector should be set up, tested and the film threaded; shades should be drawn and the screen placed at the front of the room with its lower edge at eye level. During projection of the film, the instructor should give attention to the sharpness of focus in the picture; also to the clarity and proper volume of the sound. It may be desirable to stop the projector and interpose comments, or to reverse the film in order to repeat a scene.

Of greater importance than the mechanical details is the preparation of the class for the film showing. The presentation to the class is in the nature of an assignment. indicating the relation of the film to the course outline, the important points to be given especial attention, and the previously acquired information to be utilized in relation to the film material. A one-reel film contains from twenty-five to fifty scenes, ten minutes of narration, and a multitude of visual and verbal details. All of this material is presented without selective emphasis. The instructor must indicate to the class the relative importance of the major ideas and the details presented in the film. Preparation of the class for the film showing is perhaps the most important single element of film utilization.

Following projection of a film, an immediate class discussion is desirable. Learning involves acquisition of data (through observation, reading, listening) and subsequent organization of ideas. Questioning and discussion help the student translate visual images into verbal symbols and to organize his ideas. Questioning and discussion also help the instructor determine which points are not generally understood, which students have failed to grasp essential ideas, and whether portions of the film should be reshown. It will be seen from the foregoing brief outline of film utilization that a single ten-minute film will frequently require a full class hour.

Efficient science instruction requires the use of sound films when they: (1) portray that which cannot otherwise be observed, (2) present in a few minutes that which requires hours, and (3) explain that which cannot otherwise be readily understood. Effective science instruction requires the instructor to: (1) know what is to be shown in the film,

(2) plan the use of films to complement and enhance his lectures, (3) attend to a few simple but important mechanical details, (4) make a clear and concise assignment for study of the film, and (5) conduct a discussion of the film immediately following its showing. The motion picture thus utilized becomes a useful tool for the science teacher, taking its place with the other materials, equipment and visual representations used in the classroom.

TERMITES IN MONTANA

GORDON B. CASTLE
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On the basis of published records, termites occur only in the extreme western and southwestern portions of Montana. From unpublished records and recent collections these insects have a much wider distribution in the state. The following report on the distribution of termites in Montana is based on collections at Montana State College, made available to me through the courtesy of Dr. H. B. Mills; on collections forwarded to me by Dr. William Jellison of the Rocky Mountain Spotted Fever Laboratory at Hamilton; and on collections which I have made.

Two genera of termites, each represented by a single species, are now known to be present in the state. The genus *Zootermopsis,* the damp wood termites, is represented by *Z. nevadensis.* This species has been reported previously in Western Montana. Two additional records are available for the state, one from Hamilton and the other from Missoula.

The genus *Reticultitermes,* the subterranean termites, has likewise been reported in the extreme western and southwestern portions of the state. This genus is represented in the state by *R. tibialis,* the barren lands termite. New records show this species to be present in Miles City, Hardin, Billings, Havre, Dillon, Terry, Powderville, Three Forks, Florence, and Miller Creek Canyon south of Missoula. These records extend the known range of this species some 240 miles northward in the eastern part of the state and due to their widespread occurrence suggest the possibility of a general distributon throughout Eastern Montana.

One collection of *R. tibialis* taken near Florence, Montana, is of particular interest because of its compositon. The colony was located under a rock about 10 inches square on a south-west facing slope. The carton material of the central portion of the nest was about six inches in diameter and five inches deep with many tunnels running throughout. The cell, which contained many individuals, was near the center of the mass. The population of this particular portion of the colony consisted of many soldiers and workers, a few nymphs in the last instar,, two alates, and 24 female and 8 male brachypterous reproductive forms. An investigation of the immediate vicinity of this rock showed that there were other concentrations of termites under other rocks and indicated that this colony may have had a radius of several feet.

From these records of distribution in the state it is to be thought that *Reticulitermes tibalis* will probably occur throughout the entire eastern portion of the state and in the drier valleys at lower elevations in Western Montana. In my experience this species is found associated with sage-brush, rabbit-brush, and other plants associated with semi-arid conditions.

Zootermopsis nevadensis, on the other hand, occurs only in areas where there is sufficient moisture to maintain relatively damp food throughout the year. Due to the requirements of this species it probably occurs only in the mountainous regions of Western Montana. They are not common in this area, however.

In other parts of the United States the subterranean termites are of considerable economic importance. The records for Montana indicate that although they do destroy timbers in houses and other man-made structures they do not, at present, represent an important economic factor in the state.

AN EXPERIMENT IN EDUCATION: THE ARMY AIR FORCES COLLEGE TRAINING PROGRAM

WASHINGTON STATE COLLEGE

OTIS C. MCCREERY, Co-ordinator ..... (OCM)
(Dean of Men, Washington State College)

JOHN F. RAMSEY, Assistant Co-ordinator ..... (JFR)
(Asst. Prof. of History, University of Alabama)

LEE J. CRONBACH, Supervisor, Academic Records ..... **(LJC)**
(Asst. Prof. of Psychology, Washington State College)

HARRY H. IRWIN, Supervisor, Mathematics ..... (HHI)
(Assoc. Prof. of Mathematics, Washington State College)

ALFRED B. BUTLER, Supervisor, Physics ..... (ABB)
(North Central High School, Spokane)

ORLIN BIDDULPH, Instructor, Physics ..... (OB)
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HOYT LEMONS, Supervisor, Geography ..... (HL)
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JOHN S. COIE, Supervisor, English ..... (JSC)
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NORMAN W. JOHNSON, Instructor, English ..... (NWJ)
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HERMAN J. DEUTSCH, Supervisor, History ..... (HJD)
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WINSTON B. THORSON, Instructor, History ..... (WBT)
(Asst. Prof. of History and Political Science, Washington State College)

CHARLES W. PIERSON, Supervisor, Medical Aids ..... (CWP)
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J. FRED BOHLER, Director, Physical Education ..... (JFB)
(Head of Dept., Physical Education, Washington State College)

In organizing this symposium, the persons named above were asked to prepare papers of from 500-700 words on the subject *"What Were the Lessons in the Army Air Forces College Training Program for Science Education; for Education in General."* These papers, all written independently, were read by an editorial board consisting of W. R. Hatch, Norman W. Johnson, and Lucille O. Gustafson, whose decision it was to break up the original articles and to fuse them into a single paper in which the comments of the several authors were considered, topic by topic. The board, however, did not select the topics; it simply organized the material under topical headings, the selection being made by the authors themselves in their choice of subjects. Furthermore, all the opinions expressed on any topic were included under that topic even though it resulted in duplication in some instances. This was done because it was felt that the practice best served the purpose for which this symposium, and those which are to follow, were being written; namely, to assemble data from the most authoritative sources and in the most objective manner so that any conclusions that might ultimately be drawn from them might be sound.

In the integration of the several papers into a single article, material was necessarity removed from its context and topical headings were set up under which there was, in some instances, relatively little discussion. To make certain that each writer had not been misrepresented by the removal of his remarks from their original context and to make certain that each writer had an opportunity to express himself on all topics upon which he felt qualified to write, the symposium was sent to the contributors for their review.

Comments organized in the manner of this symposium or submitted individually in letters to the editor are solicited from those institutions or persons in the Northwest who have had experience with this or a similar program.

INTER-INTRA-DEPARTMENTAL INTEGRATION

(HHI), Mathematics: "The success of the A.A.F. program at the State College of Washington was largely due to the administration of the work, the excellent cooperation between departments, and the high correlation of work given in the departments. It is to be noted that all departments held frequent faculty meetings where teaching methods and course content were discussed freely. The ideas developed there were carried on to the regular meetings between the supervisors and co-ordinator, where they were passed on from one department to another, and general policies adopted. This led to the feeling that everyone on the facfulty was responsible for the success of the work. The faculty accepted the challenge and placed W.S.C. at the top of the Western Command in accomplishment. No one on the program had the feeling that he was being dictated to by administrators, but felt that he had had a part in planning the work so that it would work best for all concerned."

(JSC), English: "In the A.A.F. program the success of the teaching of English was due in no small part to the understanding and cooperation of the other departments. In a program of this kind, the head of the department should take his place among the members of the staff and thus be able to do two things at the same time, supervise the work of his own department, and correlate it with that of the other departments. In our regular college work an understanding and an appreciation of the work of the several departments by the teaching staffs of all departments wouldmake for more effective work."

(OCM), Co-ordinator: "A factor that aided us was our attempt to breakdown divisions between departments as much as possible without destroying the advantages that do come from departmentalization. Each department was organized under a supervisor. These supervisors formed a sort of academic 'cabinet' which met with the co-ordinator and his assistant to discuss questions of policy. No question of any importance was acted on by the co-ordinator without first hearing it thoroughly discussed by the supervisors. In this way, a fairly clear understanding developed among the supervisors on the various problems and policies of each department. This procedure did not stop at the level of the supervisors, but was extended to the instructors who were also given an opportunity to discover how their work fitted into the program as a whole. Regular meetings were held for the entire faculty in which each department had an entire meeting to discuss, demonstrate, and display the work of that department. The importance of this attempt to break down departmental lines can hardly be exaggerated, and many of our faculty expressed their appreciation for the opportunity so afforded them."

(HL), Geography: "In the Air Corps program at this institution, integration of materials and methods was noteworthy. In these days of distinct departmental separation of subject matter, we might pause and reflect that the student after all must assimilate material from many fields."

ADMINISTRATIVE PRACTICE

(WBT), History: "A concern of our staff at the start of the program was the kind and degree of supervision of the academic instruction which would be exercised by the military. Generally, it can now be said that such supervision was done intelligently, with a great deal of independence and most decisions left to the academic staff.

"At first, there was a promise of something quite different. We were showered with charts and graphs on our soldier-students for which few of us found much use. We received directives from the Army on how to teach (one such stated that there should be a change in classroom technique 'every three minutes'). There was some difference of opinion on the relative place of the academic and military programs operating concurrently on the campus, and, we felt, an underestimation by some of the army officers of the primary place of the academic work here.

Finally, there was a great deal of instability in the working of the planned schedule.

"As the months passed, however, these dislocations were adjusted; the charts and directives became fewer and finally virtually stopped; the proportionate emphasis on the military and on the academic elements of the work was determined, and real stability in the schedule was obtained. The supervisor of academic instruction for this area—an A.A.F. major—assured us on several occasions that our only real concern in the history work was to present a well-organized course carrying out the basic objectives. and that our judgment and experience should determine the scope of our presentation, our classroom technique, our methods of testing and grading, and other matters of detail."

(JFR), Assistant Co-ordinator: "Two words—frankness and democracy—will summarize the administrative philosophy of the co-ordinator's office. In all questions of policy, the faculty was kept fully informed; it was given all the information available to the co-ordinator and encouraged to make decisions. Again and again the wisdom of being frank, of coming out into the open on all questions, was made clear.

"In addition, much of the success of our program must be attributed to its flexibility. We were constantly striving to adjust our methods to changing situations and to keep pace with varying army policies and demands.

"The question of salary is often a rock upon which administration-faculty good will founders. To avoid this, we strove to set a basic rate of pay that would provide a decent living wage; this rate was $250 per month. In general, academic degrees meant little. Salaries were adjusted more in accordance with personal ability and service to the program. In short, a good teacher was more valuable than a good degree. I might add that our willingness to pay overtime for overloads helped to win faculty support and enthusiasm for the program."

FACULTY MORALE

(NWJ), English: "Faculty morale was remarkably good, apparently for several reasons. The teaching contributed directly to the war effort. Again, there was the excitement of pioneering in a new type of instruction within the broad limits set down by military directives. Because the military teaching load in number of students and number of classes was lighter than a civilian load, instructors were able to do energetic classroom teaching and to devote time to experiment in ways of presenting material. There was scope for work and originality on the part of the instructor in shaping the course both in the classroom and in staff meetings. In short, the teacher became central in meeting the problems of training the men. The training was carried on under an administrative policy that evoked from the members of the teaching staff a willing cooperative effort."

(JSC), English: "An explanation offered by one of our instructors for the good morale of our faculty was: 'It is a pleasure to teach when one doesn't have to be thinking all the time about a research paper that might grow out of the teaching. I never did better teaching than I did here.'"

(ABB), Physics: "The teachers were impressed with the importance of their job. Each day's work might sometime save the life of a student if that work was done well. The teachers' response to this appreciation of the importance of their work led to the free exchange of ideas, equipment, and suggestions without fear of offense. It also stimulated the teacher to a constant effort to improve his teaching. New courses had to be organized. The old subject matter had to be presented in a different manner."

(HJD), History: "As regards the excellent morale of the staff, the first factor was the able, purposeful, and keenly responsible teachers the college was able to recruit. Scarcely less important was the leadership of the co-ordinator and his assistant. No better illustration could be found as to how confidence in the fairness of a superior created con-

fidence in and regard for administrative authority."

STUDENT MOTIVATION

(OB), Physics: "The realization that they were 'playing for keeps' furnished the principal motivating force for most students of my acquaintance. Too often college students take school for granted —as a continuation of the only thing they have done consistently for the last twelve years."

(ABB), Physics: "Motivation was one of the strongest factors which distinguished the military classes from the usual civilian classes. The men, as a direct result of this training, were to receive a commission, a raise in pay and considerable social prestige. Motivation also involved the consciousness on the part of the student of a need, and recognition of the fact that his work constituted an answer to that need.

"In discussing the concept of center of gravity the writer asked the class if any of the men could contribute an experience which illustrated its importance to flying. One man stood up and replied, 'Sir, I saw a B-24 take off and climb to a height of 100 feet then go into a spin which caused it to crash, killing eleven men. The plane's center of gravity had been figured wrong; it should not have been allowed to take off.' An example like that is all that is needed to motivate a class.

"Our experience with student motivation in this program should help in civilian teaching. We must give priority in our thinking to the motivation of the students. This does not mean serving education, chocolate coated, in a silver spoon, but we should be more conscious of the things that will motivate the members of our classes. In science this can only be accomplished by knowing more of the background and interests of our students."

(LJC), Supervisor of Academic Records: "Some men failed some courses deliberately, because they simply did not want to study them. These same men, however, often did a good job in the subjects they felt were important to them. This is a reflection of the relative maturity of these students, who constantly asked, 'What good is this to me?' If they felt that one subject led toward being a better airman, they worked hard, but they did so by taking time from studies they saw no reason for. In general, they did not neglect science and mathematics; but the implication for all teachers is that mature students will require more direct motivation than credits and grades. If the course is related to the student's goals, he will work at it.

"A particularly important type of failure was the personality misfit. Boys who felt insecure, perhaps because they did not adjust to military life, often found very troublesome ways of attempting to compensate."

(CWP), Medical Aids: "Interest seemed to be the most influential factor in attainment in the Medical Aids course. 'This is something,' in the words of the cadets, 'we can really use,'—'I have been wanting something like this for a long time.' The interest shown by those cadets who had seen action was especially keen."

(NWJ), English: "Class conduct was in general excellent. It should have considerable bearing on postwar conduct—not that civilian students should sit at attention, and stand at attention to recite, but that the alertness and attentiveness that come from discipline make teaching much easier."

SECTIONING

(JFR), Assistant Co-ordinator: "Sections were formed on the basis of academic ability and as a result of careful testing by the supervisor of records and schedules, were fairly homogeneous. I am convinced that this was a good thing. In fact, I think that high schools and especially colleges should pay far more attention to the principle of segregation than they do. The principle examination used to classify the soldiers was the mathematics test. At first. there was some concern on the part of the English and history departments that this might work a hardship on them, but practical experience soon dissipated these fears. It soon became clear that ability in mathematics normally indi-

cated ability in other subjects as well, and during the entire life of the program, we never had complaints from other departments against the use of mathematics as a means of separating 'the sheep from the goats'. Once the sections were set up, and the instructors informed of the relative academic standing of each group, curricula could be adjusted to the needs and potential capabilities of each section.

"In mathematics, for example, three general curricula were set up, one for advanced, one for average, and one for slow sections. In order to avoid injuring the student's pride, and maintain a high morale in slow classes, it must be explained to him that, in most cases, differences in achievement on the mathematics test were caused by differences in experience and academic background, and were not indicative of differences in intelligence. This was actually true in a great many instances. I am more firmly convinced than ever that this approach is a 'must' if teaching is to attain its maximum effectiveness."

(HHI), Mathematics: "In sectioning in mathematics, it was found that about one-fourth of the Air Force students had had previous college training in mathematics at least through trigonometry. The bottom fourth of these students had no mathematical training beyond eighth grade arithmetic. To throw all of these students into the same sections would be disastrous. The top group would either be bored to death, or the bottom group would be hopelessly lost from the very beginning.

"By sectioning these students and the ones in between on the basis of ability and previous training, the situation was well cared for. A minimum course was set up consisting of arithmetic drills, essentials of algebra, geometry and the simplest applied trigonometry. This minimum outline was covered by all sections. In addition, however, the more advanced sections were given such additional enrichment material that it represented a real challenge to them, regardless of their advancement. The most experienced teachers were put in charge of these top sections, and very few students had the complaint that they were bored by lack of good material. There is no doubt but that this plan recommends itself in the postwar teaching where groups are sufficiently large to admit such segregation. The plan proved also, that students of high school and college training were more pliable, and adjusted themselves more readily to a program of this sort than those with eighth grade training only. In spite of the light outline of work provided for the bottom sections, it was found that most of the failures came in this group."

(LJC), Supervisor, Academic Records: "Misclassification, a man having been placed in a group where he could not compete by reason of inferior background, was sometimes the cause for the large number of student failures (inability to pass tests). It is important for teachers to identify such cases, and to have a channel for reassigning them.

"Men who considered themselves better educated than their fellows were at times unready to accept the fact that they needed to review high school subjects. Typical 'adjustments' included not studying, to prove that they were good enough to get the work without the study others required. Other men asked incessant high-flown questions in class, to call attention to their 'superiority'. Part of this trouble may be removed if these men have an opportunity to discuss their classification and can be shown the basis for the decision that they need review of fundamentals. Another approach is to provide other outlets for their need for recognition, by giving them chances for responsibility and attention. Such cases required analysis on the basis of all the information about the student available from all sources. Faculties would do well to consider such a student together, pooling their insights, rather than separately failing him in each course."

(ABB), Physics: "Sectioning, which is so often resented in the public schools, was not resented by the men in this program, but for the most part, welcomed, as the men would rather be grouped with others of like ability and background."

(JSC), English: "The regular college English Placement Test was given to all the aviation students. The results of this test indicated that these men rated below he average incoming freshmen. This was true in a greater degree of the later arrivals. It was found that a fairly close agreement existed between the ratings of the sections on the basis of the English test and the mathematics-physics test. On the basis of class results, however, the English department feels that there would not be so close a correlation in the ratings of the *individual.*"

SPEED-UP

(HHI), Mathematics: "The results obtained in this program have led to the advancement of many new ideas and opinions regarding education in the future.

"One of these ideas is that after the war, education in general will be speeded up, extra-curricular activities eliminated, and the whole learning process streamlined similar to Army procedure. Many lose sight of the fact that in case of war, war emergency requires specialized training for various aspects of war, with attention only to the accomplishment of a single end, namely the making of a pilot, navigator, bombardier, etc., as quickly as possible, so that he will be ready for this war, not the next one. All frivolities must be eliminated to accomplish this end quickly, and the individual student is disregarded and becomes part of a mass.

"In general this is not the aim of modern education. Education is a process of growth and maturity as well as learning, and of necessity must take individual differences into consideration. Extensive streamlining destroys the opportunity to develop broadminded education or to encourage individual initiative. To say that if it takes four years of sixteen hours credit per week to prepare an engineer for a B.S. degree, that by taking 32 hours per week we can make the same engineer in two years, or at 48 hours per week we can make him in one and one-third years is not good reasoning.

"The larger engineering schools of the country have been favoring five years for engineers rather than three or four. They claim that extra-curricular activities, social sciences and engagement in more social functions would be of added value to the development of an efficient broadminded engineer . We might say that if we speed up and streamline education after the war we will narrow down the benefits in proportion. These war programs have proved valuable to develop technicians, but a college degree should stand for more than a technician."

(OB), Physics: "I know of no concrete evidence that education has been 'speeded up'. The rate of learning (the amount learned per hour spent) was not different from usual college rates. Material to be taught was selected on the basis of its pertinence to the ultimate performance of a specialized task. A certain amount of fairly basic scientific knowledge was of necessity taught, but even this, at times, was oriented toward the technological aspects. The benefits of doing so were two: to maintain a high morale, and to thoroughly steep each student in the fundamental principals of the equipment which he was to use.

"This is not a 'speeded-up education'; it is a specialized education. Training of this type is truly technical training—not basic scientific training which would be expected to yield fruitful results in research. In this war we have learned the importance of pure research far too well to hazard our future in technological training."

(ABB), Physics: "To meet a specific need the military services streamlined a physics-mathematics-engineering program in an attempt to get maximum absorption in minimum time. As a result of the methods employed, competent school men claim unusual success in *training* but not necessarily in *education.*

"Time after time air force inspectors, observing school procedures, emphasized that the students need not master physics, but that the part of the subject which they were taught was to be thoroughly taught. Possibly, we could afford to lose some of our reverence for what makes up a complete course in

physics and achieve a greater mastery of the material that we do cover."

(WBT), History: "With full understanding of the need for speed which the war situation required and of the fact that scholarly attainment was not the primary objective of the programs, I believe that the demands upon the men were too great to allow effective grasp of the subject matter, intellectual 'digestion', and performance on the level of real scholarship. Generally speaking, the performance in the history classes, where some grasp of ideas and concepts as well as of events and personalities was required, was below that of a college freshman course. With strong incentive, greater maturity, and often considerable interest, the aviation student lacked the fundamentally necessary time and 'leisure' which brings greater substance, understanding, and assimilation of academic material. Those who would 'streamline' the postwar college program should be aware of this. It should serve as a warning."

(HJD), History: "The teachers of the history course, without exception, are convinced that heavy loads and speed-up procedure may serve their purpose in technical training but not in education. The latter requires reflection, and whereas concentration is desirable, the time element cannot be measured."

(LJC), Supervisor of Academic Records: "Teachers occasionally were led by the speed of the program to attempt to cover the entire outline, regardless of whether a class had mastered one topic before going to the next. For men of this type, and they are not very different from normal students, this practice led to demoralization, since men barely mastered one difficulty before being presented a new one. The solution is to stay on one topic until all but the 'hopeless' men have learned it thoroughly, even if it is not possible to complete the course. This implies the necessity of reducing courses to eliminate any unimportant topics.

"Perhaps the most striking aspect of the program was the high speed at which materials were covered. Student loads often were double what the normal student has been carrying, and new demands from academic and military quarters provided constant pressure to load them down further. Experience proved that students can carry these heavier loads, though outside study necessarily decreases as you add class hours. On the other hand, we also learned that there is a certain point beyond which loads cannot be increased. Men must have some time each day for personal interests and relaxation; if the schedule reaches the saturation point, they will neglect academic activities that do not interest them, in order to have free time. Physics tutorial sessions were provided in the evenings on a voluntary basis, and were well received, although men had been in class from 7:30 to 6:30, with only about ninety minutes of free time. When a change of schedule absorbed this former free time, tutorial attendance immediately dropped."

(NWJ), English: "For purposes of training in an emergency rather than for purposes of liberal education, the speed-up did little real harm.

"However, the student's load was too great for any other purpose than that of meeting an emergency. Some men (sometimes a section) became demoralized. There was simply too much to do."

(JSC), English: "I do not recommend this feature of the program."

(CWP), Medical Aids: "One important result of the shortness of time was the preparation of an instructional outline. This outline, which was under continual revision, was rather detailed on the key points of the course, but left ample room for expansion in the case of faster moving classes."

SPEED-UP AND THE LABORATORY

(OB), Physics: "The one hour laboratory each day was a fortunate selection as the physical drain on the men would have made longer laboratory periods impractical. The short laboratories forced the instructors to have equipment ready and experiments efficiently planned. This is a definite economy of student time which is not often observed in longer periods.

"The laboratory period was also used for problem work. Each experiment was accompanied by problems of direct application to aircraft which incorporated the physical principles presented in the experiment. Open discussions, beyond a certain point, were wasteful of time. If many problems arose, they were handled individually or in small groups while the remainder continued their work. No problems of importance were allowed to go unsolved even though this meant cutting down on the volume of laboratory work accomplished. In short, the plasticity of the instructor's program, enabling him to give individual attention where needed, was paramount to success in laboratory work.

"All experiments were individual problems in themselves and were always directly concerned with the lecture principles for the day. As lecture sections were very large most of the actual discussions took place in the laboratory where individual help could be given. The equipment was always simple and chosen for the efficiency and facility with which principles could be grasped.

"The organization of the laboratory was such as to encourage objective thinking. Many startling examples of projected reasoning were observed. Often there was some confusion in the students' minds at the beginning of the laboratory course, but more often than not after some weeks the student stood in awe of his own accomplishments. The realization that his own mind was capable of some really startling accomplishments in objective thinking was the greatest motivation force that the student experienced. The success of the laboratory was determined by the extent to which the students were brought to this realization."

CHECKS ON ACCOMPLISHMENT

(JFR), Assistant Co-ordinator: "By means of the ratings set up by Santa Ana, we were able to evaluate in a general way our academic achievement. Before aircrew students were sent here, they were tested in all five subjects by an examination known as the AC20A. After going through our preflight training here, they were tested again at Santa Ana, in all five subjects (mathematics, physics, geography, history, and English, and their grades compared with the results of the earlier AC20A grades. In this way, the relative improvement of the cadets as a result of their college preflight training could be determined. This was done for each class reaching Santa Ana, and the results were sent back to the college. Although this device was by no means a water-tight method of checking the value of the academic work, it was none-the-less valuable as a general check on the approximate efficiency of the training. As such, it was welcomed by our faculty and administration, and was of considerable use in keeping our standards high.

"Another sort of evaluation was the questionnaire filled out by each graduating squadron in which the squadron was given an opportunity to express its opinion of academic work. The results were tabulated and shown privately to the various departments. Although such criticisms needed to be used carefully, a good deal of valuable information was often obtained.

"Classroom visitation by supervisors, the co-ordinator and his assistant also helped to improve the quality of the teaching.

"All departments except history eventually devised standardized examinations for their courses. In the case of history this proved to be impossible because of uncertainty among army authorities as to what should be included in course content. In the other departments, the standardized examination proved its value in many ways. It helped to establish uniformity of subject material among the various classes in any one department; it made possible a fairly accurate evaluation of the relative progress of the different sections; and it occasionally revealed defects in teaching. In all cases these examinations were as objective as human ingenuity could make them. I am well aware that there is opposition to the standardized, objective-type examination in many quarters, and I realize that many college teachers would object, in the name of academic freedom, to any attempt to 'streamline' the subject ma-

terial of their department. Without attempting to enter that particular argument, I must say that in our situation, where we were teaching short, specific courses with a high degree of concentration and with clearly defined goals, some standardization was imperative. Perhaps the foregoing description ought to apply to American education in general; however, one needs no great familiarity with our educational process to say that it does not."

(HHI), Mathematics: "The mathematics department used uniform standard examinations at the completion of each squadron's training. The same examination was given to all sections of the squadron. It covered the minimum outline which had been previously set up.

"The method of examination had three points in its favor. First, it caused all instructors to stick to the job of covering what the Army recommended as essential for the course. Second, it gave the instructor a measure of his success and showed up his weaknesses. Third, it had a tendency to cause instructors to be more uniform in their grading standards.

"Some class visitation was carried on by administrators, but not with the idea of telling the teachers 'how to teach'. Each individual has special methods that have made him successful and teachers should be given freedom by administrators in their special method of presentation. Visitation was carried on more for the purpose of improving organization and standardizing course content than for criticism of teaching."

(HL), Geography: "In the matter of academic supervision, civilian education, especially on the college level, might profit from our experience. In order to attain course objectives our courses of study were standardized as far as minimum essentials were concerned. Periodic visitation by the supervisor served the functions of helping to keep all classes fairly well together, and of making friendly comments and suggestions on such items as classroom procedure, use of materials, lighting and ventilation, etc. Although teachers tend to be individualists and sometimes resent interference in their work, more supervision tactfully handled should prove valuable in civilian circles."

(JFB), Physical Education: "At the end of the program the physical education department made a general survey, in the form of an unsigned questionnaire, of one of the squadrons that had been here for five months. The men were asked what form of exercise they felt was most beneficial to them. The majority of them stated 'calisthenics' and 'cross country'. Yet these two activities were the ones that they 'detested' most.

"When the question was asked, 'Would you prefer this type of exercise when you return to college after the war?', again the majority of them said 'yes'. They further stated that they preferred to have daily periods of 50 minutes each. In the final analysis they were willing to undergo the hardships for the benefits derived therefrom. This finding might be applicable to our academic work as well.

"One of the educational lessons that we received through this program was the value of tests and measurements. We found that the students were decidedly interested in knowing what progress they were making. They were constantly trying to better their marks and were trying to reach the standard as set up by the Western Command, which of course many of them reached."

POSTWAR ADMISSION PRACTICES

(LJC), Supervisor of Academic Records: "The variety of abilities among soldier-students presented problems to which college formerly gave little attention. Differences present among normal students are exaggerated in any army group to such a degree that provision for them must be made. Army students differed widely in academic background; but classification on the basis of previous education alone could not be adopted, since men of equal background often possessed very different abilities. Men who had been out of school for ten years were now eager to resume learning, but many of them had forgotten the basic materials of

the courses they once took. On the other hand, an occasional student had great ability, even along such technical lines as mathematics and physics, although he had never taken those courses.

"If college after the war can practically do so, it probably would be well to admit men to courses on the basis of achievement tests in the prerequisite subjects, rather than on the basis of credits recorded. Many returning soldiers will wish to take up technical college training, but will have forgotten so much basic material that review will be necessary. Others, because of recent technical experiences, may be better equipped than they were upon entering the Army. Those who require review should not be asked to repeat in a systematic sequence every course that they have forgotten. Time will be as precious to returning students as it was in the Air Force program. If short review courses can be worked out for men who have previously taken the basic subjects, it should be possible to refresh them on the parts of those courses they will need in their college work, without taking the time for complete coverage of the course. In general, Air Force students who had forgotten a subject were able to renew their former knowledge fairly easily."

EDUCATION FOR CITIZENSHIP

(WBT), History: "It was obvious that the history course in the A.A.F. program could have been made into the purest propaganda. The title accorded our course, 'History and Americanization', was not reassuring. However, the arrival of the outline of the course, sent from the Army Air Forces Training Command Headquarters, demonstrated that the material was of a scholarly nature and a very acceptable kind of indoctrination in democratic development, principles and ideals. The work, it declared, was to be 'built around the assumption that modern history is concerned with the following three major issues:

a. The struggle within the nations to make political power responsible by substituting democratic for autocratic government.
b. The attempt to distribute more equitably the material means of life, and to promote equality of opportunity.
c. The conflict between national power . . . and the demands of a civilized international community.'

"It seemed to us that this was a wholly satisfactory, liberal, and forward looking basis for a study of recent history in such a program.

(HL), Geography: "At no time did the Army attempt to dictate or narrowly prescribe what should or should not be taught. It is an interesting commentary on our way of life that even during a vital struggle academic freedom should be encouraged by the military."

(WBT), History: "I commend the reasonableness and good sense of the directors of the program in leaving so much to the decision of the various schools, the separate departments, and the individual instructors. If it is done in this pattern and in this spirit, I would look with equanimity upon a greater role for federal authority in postwar higher education."

(HJD), History: "There was an inherent aversion on the part of many cadets to any liberal subjects, but even those who favored them in time of peace felt that one could dispense with them in war. A gratifying number of those trained at the State College, however, expressed their determination to get an *education* after the war.

(WBT), History: "Correspondents from the fighting fronts and reporters from camps within the United States have written that generally the one consuming desire of the American soldier is to get the war over and to get home, and that he has little interest otherwise in the issues of the war and little concern otherwise with the postwar world. From my observations, exactly the same view was held by the great majority of army men who received this college training.

"The men reacted quite differently to the three divisions of our history course. They were usually decidedly interested in the section on the immediate background of the war and the war it-

self; they responded enthusiastically to the numerous short films on the war which they were shown and they participated with interest in discussions of current events, which by their questioning usually became a consideration of war strategy. However, the material on the development of America's democratic institutions and traditions, about which many of them were thoroughly uninformed, won from a majority an apathetic response. It was something, they claimed, which they had had in their early school years, which was 'ancient history' and for which they could see little practical application. Finally, with some exceptions always, the men were least interested in the consideration of the meaning of the war and of the challenge of the postwar world. Many of them were cynical and skeptical and some actually resented discussion of such matters: What concern could they be of theirs? Weren't they busy fighting a war? Wouldn't the 'politicians' settle the whole thing to suit themselves anyway? Sometimes the misinformation, the prejudices, the bigotry — anti-Russian, anti-British, anti-liberal, anti-labor, anti-Semitic, anti-Negro sentiments—prevalent in many American communities were loudly and vigorously voiced. To try to instill an honest appraisal and appreciation of the debt we owe our great fighting allies, of the need for postwar international organization, of the fundamental soundness of the democratic tradition, of the ability of an enlightened American public to determine their destiny, was some of the hardest work I have ever done in a classroom. The results of all this labor, I fear, were not great. Some few were probably convinced, but the majority undoubtedly left the classes with the same cynicism, the same prejudices, and the same assuredness as they had always had. A few hours of classroom discussion could hardly eradicate attitudes ingrained since childhood—attitudes for which the American schools are in no small degree responsible.

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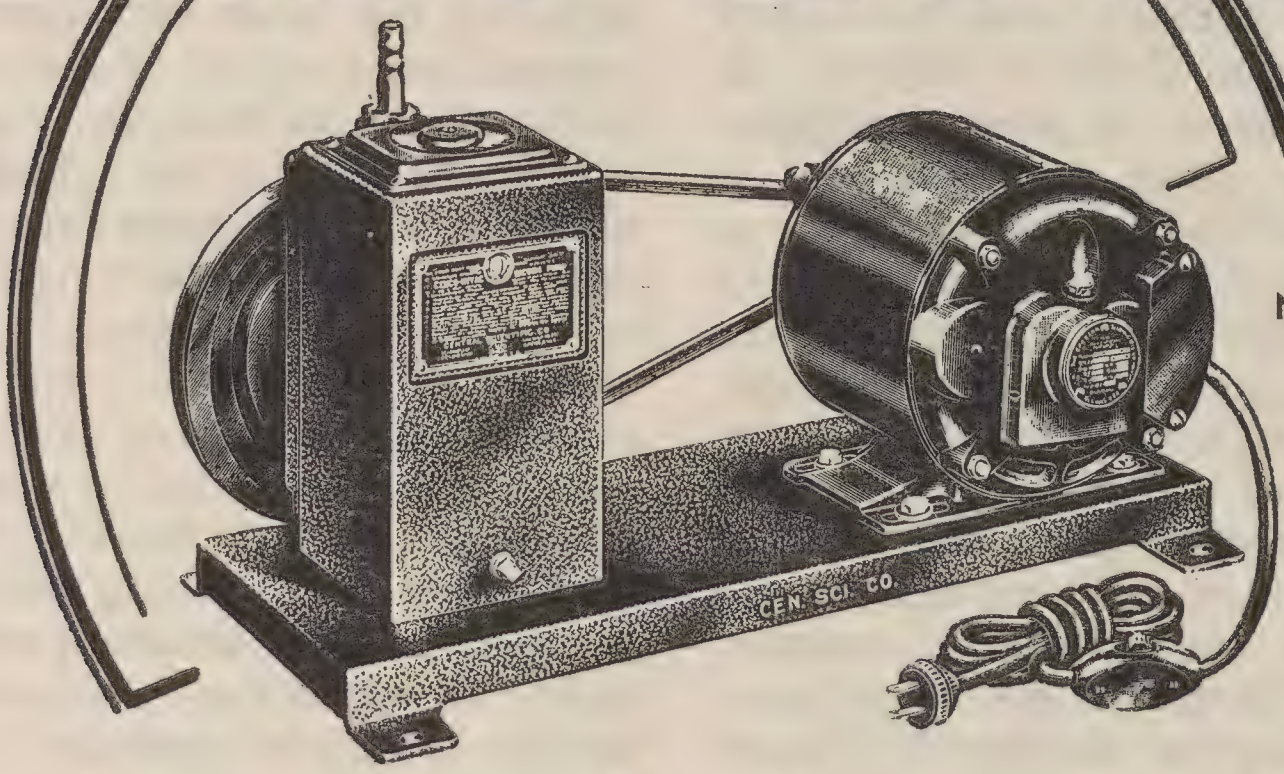

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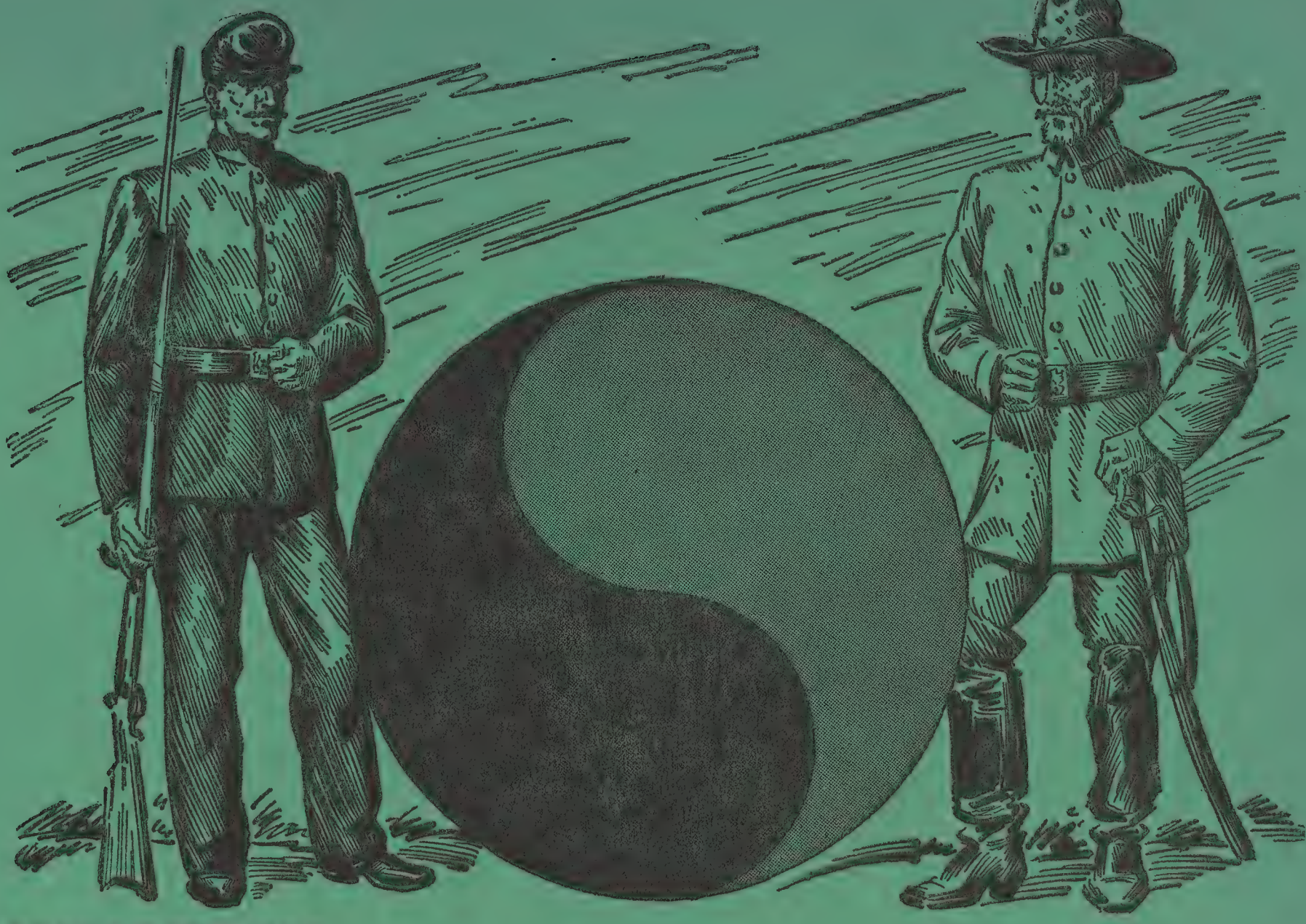

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COMMERCIAL PRINTING DEPARTMENT

NORTHWEST SCIENCE

November, 1944

Vol. XVIII, No. 4

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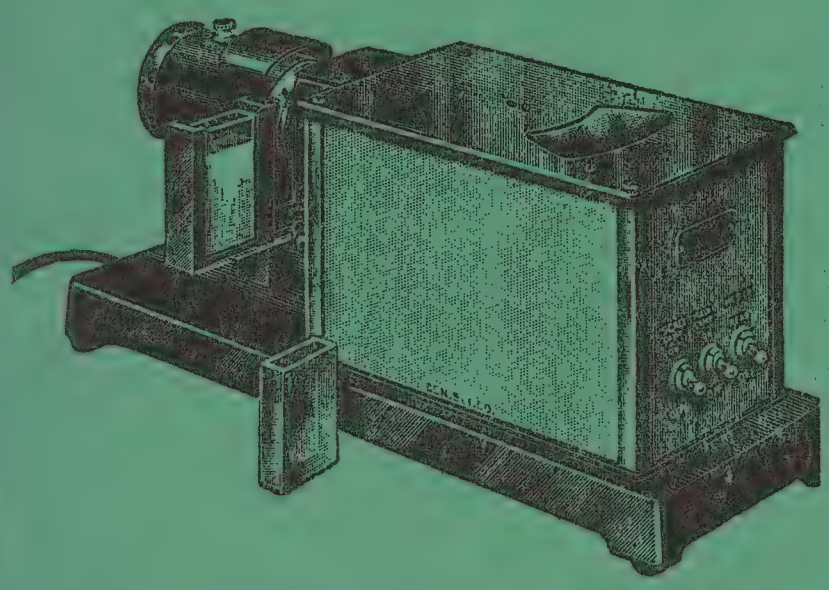

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NORTHWEST SCIENCE

Volume XVIII, Number 4

1944

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Published quarterly by the Northwest Scientific Association

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

APR 13 '45

NORTHWEST SCIENCE

VOL. XVIII, NO. 4 NOVEMBER, 1944

Published March, 1945

Editor, W. R. HATCH, State College of Washington

To Our Readers:

NORTHWEST SCIENCE calls your attention to an article in this issue, "AN EXPERIMENT IN EDUCATION: THE ARMED FORCES COLLEGE TRAINING PROGRAMS, UNIVERSITY OF IDAHO". This article is the second in a series dealing with the military training programs with which this and other institutions in the Northwest have been preoccupied during the last two years. It is the purpose of this article and of the whole series to evaluate these programs with an eye to discovering *What the Lessons in the Military Training Program/s were for Science Education; for Education in General.*

In this evaluation, however, it is essential that we be as critical and as objective as possible for it is quite as important for us to know which practices and methods cannot be adapted to civilian education as to discover those that may have application. It might also be emphasized that every effort has been made to enlist the most qualified persons on the several campuses and to handle all data as objectively as possible.

The following schools have been invited to participate in this study: Central Washington College of Education, Eastern Oregon College of Education, Montana State College, Montana State University, Oregon State College, Reed College, University of Idaho, University of Oregon, Washington State College, Western Washington College of Education, and Whitman College. Of these eleven institutions, five, Central Washington College of Education, University of Idaho, University of Washington, Washington State College and Whitman College, have already submitted articles. It is hoped that the other institutions will also wish to evaluate their experience. Comments organized into symposia or submitted individually in letters to the editor are solicited from any institution which has had experience with one of these military training programs.

Anyone wishing to subscribe to NORTHWEST SCIENCE ($1.00) or interested in obtaining reprints of articles appearing in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

The Editor.

POSTGLACIAL VEGETATION OF EASTERN WASHINGTON[1]

HENRY P. HANSEN
Assistant Professor of Botany, Oregon State College

INTRODUCTION

The age and correlation of the pollen-bearing sediments in the Scablands of eastern Washington are to be largely determined by the relation of their sites to the time of deglaciation, although the scablands themselves were not covered by the ice sheets. The last Pleistocene glacier of Wisconsin age encroached upon the Columbia Basin in two main sectors. The Okanogan ice lobe extended down the Okanogan River valley and into the Columbia Basin between the Grand Coulee and the Columbia River to the west. It blocked the Columbia River and diverted its waters through the Grand Coulee. The Spokane ice lobe, possibly of earlier origin, pushed south of the Spokane River farther east and on a broader and more irregular front (Flint, 1937). For some time during the advance and retreat of the Spokane ice, glacial waters drained southwestward and were partially responsible for the formation of the Channeled Scablands (Bretz, 1923). This area is characterized by a system of anastomosing channels or coulees, cut into solid basalt and by the remnants of the former relief. Many of these channels, which carried great volumes of water in glacial time, carry no streams at present. Others still carry intermittent, and a few have permanent streams. Rockbound lakes are common where the coulee floors have been deeply excavated and scoured. Other lakes have been dammed in the larger valleys by delta deposits of tributary streams, in oxbows on aggraded floodplains, in plunge basins at the base of abandoned rapids, and in yet other types of depressions on the valley floors.

It can be assumed that the postglacial organic sedimentary columns in the Channeled Scablands are about the same age. It is possible, however, that those channels first abandoned by meltwater potentially hold the oldest pollen-bearing profiles. As the ice retreated from the Columbia Basin, and the Columbia and Spokane Rivers carried more and more of the meltwater, the scabland channels separated from the Spokane and Columbia river drainage system by the highest divides were probably first abandoned. It seems probable that postglacial sedimentary columns in the Channeled Scablands are as old or older than most in the entire Pacific Northwest. They are undoubtedly older than those north of the Spokane River.

LOCATION AND CHARACTERISTICS OF THE BOGS

This study is concerned with the pollen analyses of four sedimentary columns located in eastern Washington and their translation into postglacial vegetation and climate. Two of them are from swamps that have developed in scabland channels south of the Spokane ice border, while the other two are from sedimentary beds lying upon glacial drift within the glaciated region. One of the sedimentary sections was obtained from a swamp located about 15 miles due west of Harrington, Washington, on the floodplain of Lake Creek which flows in a scabland channel. The sediments have accumulated in an abandoned oxbow, probably formed when a greater volume of water was carried by the channel. The depth of the pollen-bearing sediments which rest directly upon basalt, is 6.5 meters. The sediments contain considerable inorganic material, mostly at the bottom and near the top. The upper six inches of sediments are somewhat mucky and oxidized because of grazing and flooding in more recent time. Limnic peat is present from the bottom to 3.8 meters, and fibrous peat composed of sedges, rushes, bulrushes, cattail, burreed, and water smartweed completes the profile. The volcanic ash stratum, typical of most Washington postglacial organic sedimentary columns, is present at 3.4 meters.

[1] Published with the approval of the Monographs Publications Committee, Oregon State College, as Research Paper No. 87, School of Science, Department of Botany. The expenses of this project were defrayed by a grant-in-aid from the General Research Council, Oregon State College.

A second sedimentary section was obtained from a swamp formed in a scabland channel about 10 miles east of Wilbur, Washington. This swamp is situated near the edge of the timbered zone, and an occasional western yellow pine (*Pinus ponderosa*) occurs on favorable local sites. The surface is covered with a swamp associes of plants, with standing water in the center. The latter contains both floating and submerged seres. The thickness of the organic sediments in the area of sampling is 2.6 meters, and they rest directly upon basalt. Silt is the principal component of the lowest decimeter of sediments, followed upward by 2 meters of limnic peat and about 0.5 meter of fibrous peat composed of sedges, cattails, bulrushes, and water smartweed. The volcanic ash stratum occurs at 1.2 meters, while a sharply defined layer of diatomite is present at 0.4 meter. To the naked eye, these two strata look very much alike, while palpably they are also similar. The relative stratigraphic position of the ash suggests that the age of these sediments is probably about the same as those near Harrington in spite of the difference in thickness. The former, lying nearer the border of the Spokane drift, may be slightly younger.

A third sedimentary section was obtained from a swamp at the head of Liberty Lake, located about 15 miles directly east of Spokane. The lake was ponded in a tributary of the Spokane River by aggrading of the main valley with glaciofluvial material during the retreat of the last glacier. The rate of deposition of pollen-bearing sediments has been augmented by deltaic sediments by the incoming stream at the head of the lake. The surface supports an associes of swamp plants. The thickness of the sediments in the area of sampling is about 7 meters. The lowest 1.5 meter consists of silts and clays, followed upward by 3.5 meters of limnic peat, which in turn is overlain with 2 meters of fibrous peat composed largely of sedge, cattail, and bulrush. The volcanic ash stratum occurs at 4.5 meters. At Newman Lake, across the Spokane River valley to the north, the thickness of a sedimentary column obtained is 7.3 meters with the ash at 4.5 meters (Hansen, 1939). As Liberty and Newman lakes are of the same genesis, and formed during the last glacial retreat, they are probably of about the same age.

A fourth sedimentary column was obtained from a sedge meadow at the south end of Eloika Lake, located about 25 miles northwest of Spokane. Eloika Lake has been ponded in a branch of the Little Spokane River which empties into the Spokane River near the city of Spokane. The sedge meadow comprises some 100 acres and the organic sediments are generally shallow. In the area of sampling, the maximum thickness is 5.0 meters, with about 2.5 meters of limnic peat overlain with about the same thickness of fibrous sedge peat. The volcanic ash stratum occurs at 1.75 meters, which is relatively higher in the section than in most sedimentary beds in Washington.

The Harrington and Wilbur profiles are probably older than those at Liberty and Eloika lakes, if permanently ponded water in the scabland channels was available for sedimentation soon after they were abandoned by glacial meltwater.

VEGETATION OF ADJACENT AREAS

The Harrington and Wilbur sediments are located in the timberless Arid Transition life area, while Liberty and Eloika lakes are situated in the timbered zone of the same life area (Piper, 1906). The Harrington swamp is located nearest to the warmer and dryer Upper Sonoran life zone, a few miles north of the boundary of the largest area of this zone in eastern Washington.

The characteristic vegetation of the Upper Sonoran life zone consists largely of grasses, Composites, and Chenopods. The most conspicuous plant of this area is sagebrush (*Artemisia tridentata*) which is anemophilous and represented by its pollen in the sedimentary columns. Other characteristic shrubs are antelope brush (*Purshia tridentata*), rabbit brush (*Chrysothamnus nauseosus* and *C. viscidiflorus*), wingscale (*Atriplex canescens*), hopsage (*Grayia spinosa*), winterfat (*Eurotia lanata*), horsebrush (*Tetradymia canescens*), greasewood

(*Sarcobatus vermiculatus*), and stiff sagebrush (*Artemisia rigidus*). Common forbs are silver saltbush (*Atriplex argentea*), seepweed (*Suaeda depressa*), and false tarragon (*Artemisia dracunculoides*), and various species of Eriogonum, Erigeron, Penstemon, Lupinus, and Astragalus. There is a large number of grasses that thrive in the Upper Sonoran life zone, but as their pollen is practically impossible to separate, there is no need for enumerating the many species that might be represented by their pollen in the sedimentary columns. The pollen of the above groups is the most abundant of non-arboreal species, and their recorded postglacial trends are significant climatic indicators. Although none of the sedimentary columns is located in the Upper Sonoran life zone, paleic expansion and contraction of this phytogeographic area are apparently recorded in the profiles.

The timberless Arid Transition area forms a belt between the Upper Sonoran and the western yellow pine forests that barely encroach on the northeastern part of the Channeled Scablands. This timberless area is also called the Bunchgrass Prairie. The principal grasses include *Agropyron spicatum, Poa secunda, Festuca idahoensis,* and several species of Bromus. Many other species are common. Characteristic forbs are *Balsamorhiza sagittata, Achillea lanulosa,* and *Wyethia amplexicaulis,* and several species of Lupinus, Lomatium, Astragalus, Erigeron, and many others.

Eloika and Liberty lakes lie within the timbered portion of the Arid Transition area. The principal arboreal species is western yellow pine, and this floristic province is called the yellow pine belt. This tree is the most xerophytic forest tree of the Pacific Northwest and extends farther down on the east slope of the Cascades and into the Columbia Basin than any other forest tree. Its postglacial pollen record is an important indicator of climatic trends. Other arboreal species in the yellow pine forests are lodgepole pine (*Pinus contorta*) and Douglas fir (*Pseudotsuga taxifolia*).

The Canadian life zone lies to the north and east of the Arid Transition at higher elevations. Here the forests are composed of Douglas fir, lodgepole pine, western larch (*Larix occidentalis*), lowland white fir (*Abies grandis*), western white pine (*Pinus monticola*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and Engelmann spruce (*Picea engelmanni*). With the exception of western red cedar, all of these species are represented by their pollen in the sedimentary columns. Mountain hemlock (*Tsuga mertensiana*) of the Hudsonian life zone at higher elevation is sparsely and sporadically recorded in all of the profiles, in spite of its present great distance from the sites of the sediments.

POSTGLACIAL VEGETATION HISTORY

In addition to the four sedimentary sections of this study, three others in the same general area, upon which the author has published, will be correlated with them. These are located at Newman Lake, about 20 miles northeast of Spokane across the Spokane River valley from Liberty Lake (Hansen, 1939), at Fish Lake, a few miles northeast of Cheney (Hansen, 1943a), and at Crab Lake, about 30 miles southwest of the Harrington section (Hansen, 1941). The first two lie within the yellow pine forests, while the last is located within but near the northern border of the main body of the Upper Sonoran life zone. These seven sedimentary columns contain pollen profiles which are generally similar with respect to the indicated climatic trends.

Lodgepole Pine

In all four sedimentary columns lodgepole pine was the predominant arboreal species as the ice retreated from the Columbia Basin and in areas to the north (figs. 1, 2, 3, 4). In the other three profiles it likewise was the predominant pioneer arboreal invader. Although lodgepole pine may be generally over-represented in many sediments because of its enormous amount of pollen produced at an early age, its consistently well-defined majority in most Pacific Northwest columns at the lower levels suggests its initial postglacial predominance. Its ability to thrive under un-

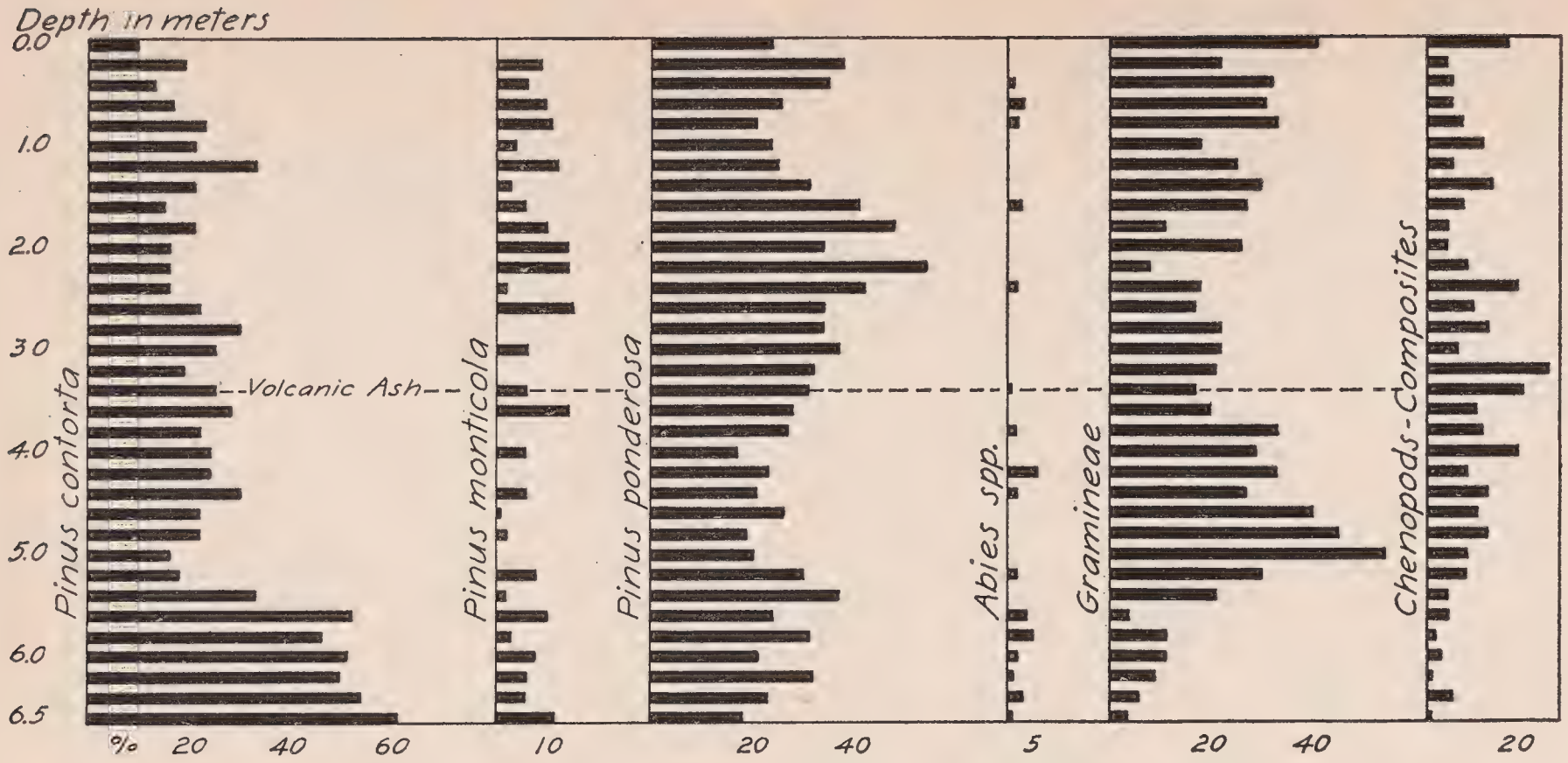

Fig. 1.—Pollen diagram of Harrington sedimentary column.

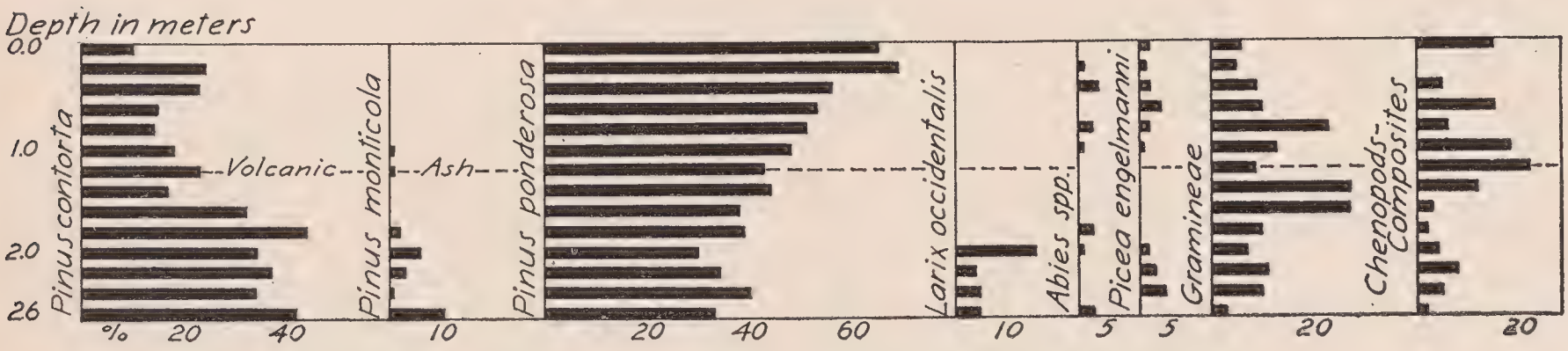

Fig. 2.—Pollen diagram of Wilbur sedimentary column.

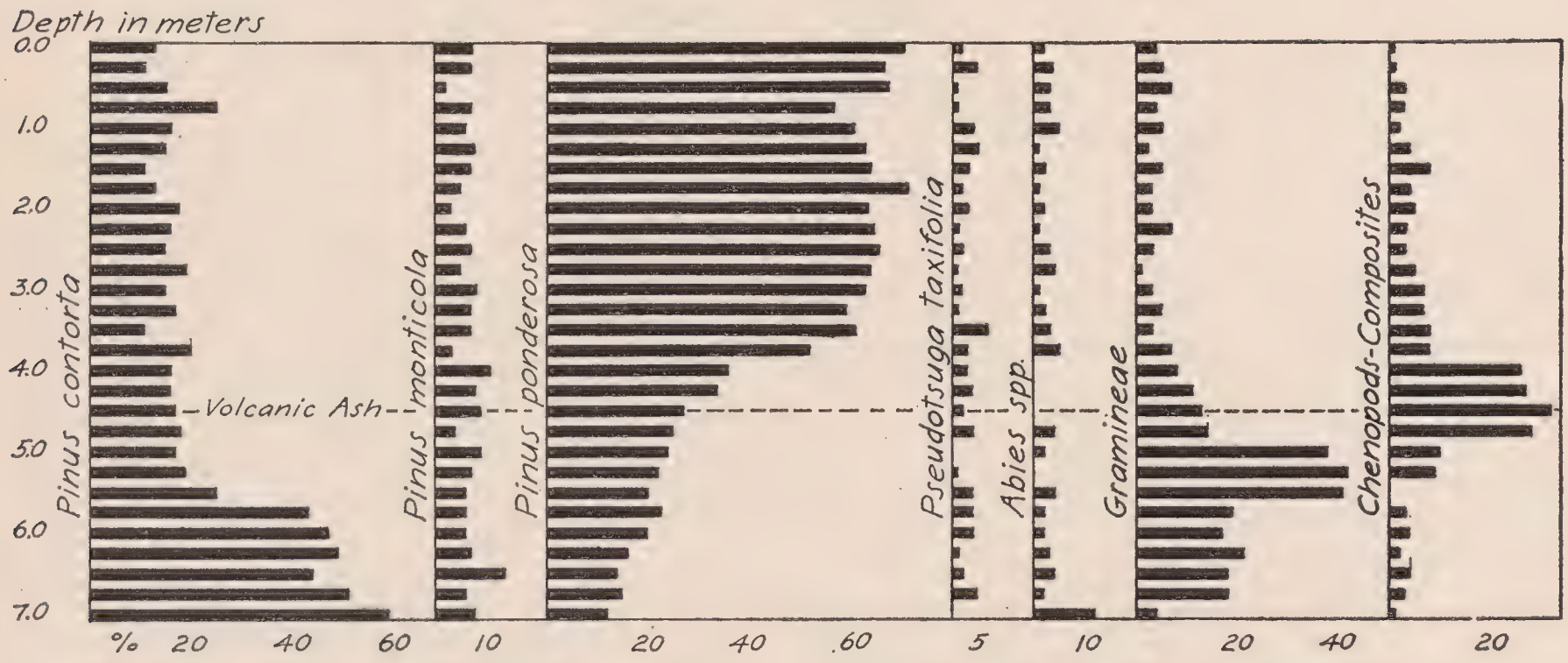

Fig. 3.—Pollen diagram of Liberty Lake sedimentary column.

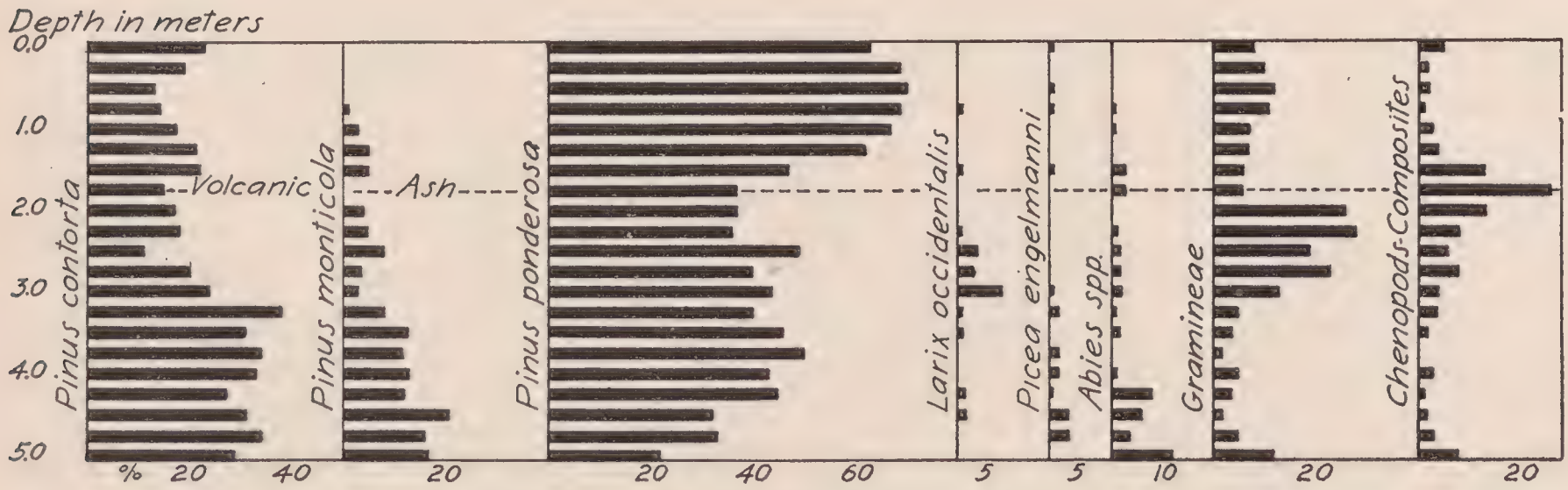

Fig. 4.—Pollen diagram of Eloika Lake sedimentary column.

stable physiographic and edaphic conditions, unfavorable for other species, as shown by its present distribution and habits suggests that its early postglacial pollen record is fairly indicative of its actual status. In those sedimentary sections south of the timbered area and drift border of eastern Washington, the abundance of lodgepole pine pollen in the lower levels and its gradual decrease upward to its minimum suggests that this species was pushed southward into the Columbia Basin by the advancing ice. It persisted for some time after the maximum ice advance. As the physiographic and edaphic conditions became stable, and the climate warmer and dryer, it was replaced by other species. The average of seven profiles in this region shows the consistence of the early postglacial lodgepole predominance and maximum (fig. 5). In other areas of the Pacific Northwest, lodgepole has likewise been a pioneer postglacial invader, particularly in the Puget Sound region and the Willamette Valley (Hansen, 1941a, 1942).

Western White Pine

Western white pine, a characteristic tree of the Canadian life zone, is slightly more abundant in the lower than the middle or upper levels (figs. 1, 2, 3, 4). This species requires a cooler and moister climate than lodgepole pine, Douglas fir, or western yellow pine. In general its maximum proportions occur in the lower levels of most Pacific Northwest sedimentary columns, which is consistent with its climatic requirements. It is not as aggressive as lodgepole pine under unstable physiographic and edaphic conditions, and therefore was not predominant during early postglacial time. This is true even in northern Idaho, where at present western white pine attains its maximum development (Hansen, 1939a, 1943). The average of the seven pollen profiles of western white pine shows that it has been most abundant in early postglacial time, but apparently conditions were not as favorable then as they are now in northern Idaho (fig. 5).

Western Yellow Pine

As the influence of the retreating glacier waned, and the climate became warmer and dryer, western yellow pine expanded at the expense of lodgepole. In the lower levels it is appreciably represented, but not so well as lodgepole (figs. 1, 2, 3, 4). Apparently the unstable physiographic and edaphic conditions were more favorable for the latter. The smallest representation of yellow pine is in the lower levels, indicating that as a forest it did not retreat southward before the advancing ice. It was

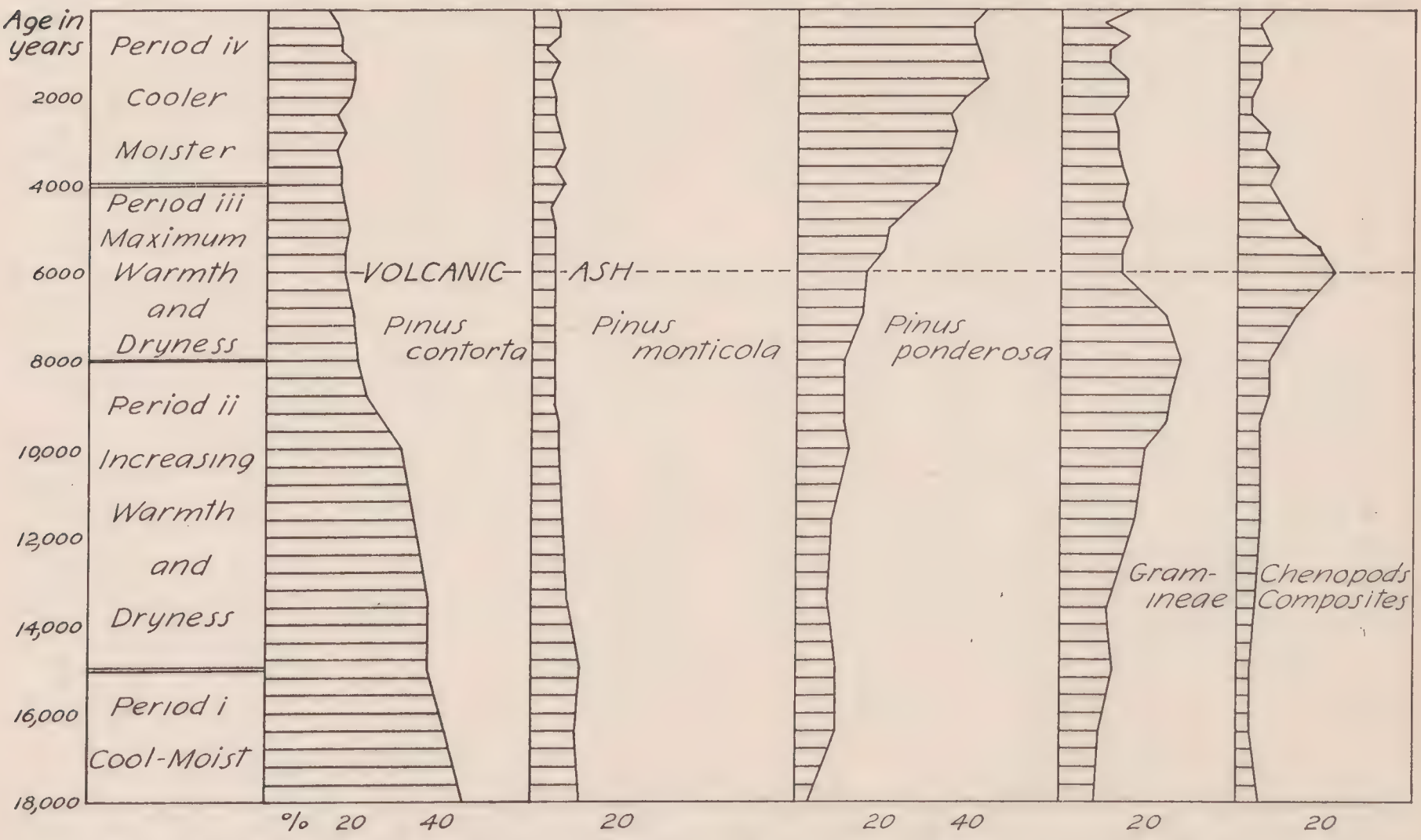

Fig. 5.—The average pollen profiles of the principal species and groups of plants in seven sedimentary columns in eastern Washington.

largely destroyed or occupied interlobate areas. If it had retreated beyond the southernmost profile of this study, then its readvance should be recorded by its maximum pollen proportions at some point between the bottom and the volcanic ash horizon. In three of the profiles, yellow pine did expand immediately from the bottom and then decline below the ash layer, but this was probably in response to warming and drying that reached a maximum about the time of the volcanic activity (figs. 1, 2, 4). Although it may have persisted closer to the sites of the more southern swamps during the glacial period, its present existence at great distance is apparently in much greater abundance. In the Crab Lake profile, farthest removed from the present-day forests, yellow pine is most poorly represented throughout, with a maximum of 28 per cent at a point above the volcanic ash stratum (Hansen, 1941). In the other six sections the maximum ranges from 54 to 71 per cent. It is significant that in the Harrington profile, next farthest south, the next lowest maximum is attained, also above the ash stratum (fig. 1).

The average of the seven profiles of yellow pine reveals a more or less constant trend from the bottom to the ash horizon (fig. 5). The early postglacial expansion was arrested by warming and drying which reached a maximum during the Middle Postglacial about the time of the recorded volcanic activity. Its expansion to the status of climax dominance, as it holds at present, was held in abeyance until increased moisture and lower temperature in more recent time. This is most clearly shown in the Harrington and Eloika Lake sedimentary sections (figs. 1,4). Its most rapid rate of expansion occurred soon after the time of the volcanic activity. In all columns the yellow pine maximum occurred sometime after this geological event. In all but the Harrington profile it attained its greatest proportions at or near the top.

Grasses

Although grasses are an important group in the present vegetation of the non-timbered areas of eastern Washington, they attained their postglacial maximum before the volcanic eruption recorded by the ash stratum (figs. 1, 2, 3, 4). The highest proportion of grasses is attained in the Harrington profile, where it reaches 54 per cent. In only the Crab Lake profile does this group attain its maximum representation above the volcanic ash horizon. This trend of grass succession suggests that the gradual drying and warming of the climate favored its expansion at the expense of western yellow pine. Its decline before the volcanic activity suggests that warming and desiccation progressed beyond the optimum and it was partially replaced by Chenopods and Composites. Grass is probably under-represented by its pollen in the sedimentary columns so that its highest proportions become more significant.

Chenopods-Composites

Although the warm, dry Middle Postglacial had reached a significant degree before the recorded volcanic activity, as disclosed by the grass maximum, it may not have attained its peak until the time of volcanic activity. This is denoted by the maximum of Chenopods and Composites at or near the ash level (figs. 1, 2, 3, 4). This trend may reflect the culmination of the xerothermic interval in two ways. First, the dry conditions in themselves would have encouraged the expansion of Chenopods and Composites, especially those of the Upper Sonoran life zone. Second, continued warmth and dryness would have tended to evaporate many of the more shallow lakes, leaving alkaline areas which may have been taken over by halophytic species of these two plant groups. Although the second condition was probably local, it contributed to the record of these two groups. About the time of the recorded volcanic activity they were the predominant flora within range of pollen dispersal to the sites of the sediments of this study (fig. 5). After their maximum they are not abundantly represented.

Other Species

Other arboreal species recorded by their pollen in the sedimentary columns include Douglas fir, two or three species

of balsam fir, Engelmann spruce, western larch, western hemlock, and mountain hemlock. All these species require more moisture than western yellow pine, and with the exception of western larch, their general higher proportions in the lower levels, their decrease through the middle horizons, and their slight rise in the upper levels, supports the other evidence for a Middle Postglacial xerothermic stage. In the Eloika Lake profile an influx of larch near the middle suggests severe fires in the forests to the north, while in the Wilbur profile, an abundance of larch in the lower four levels is also indicative of pyric influence within range of pollen dispersal. Temporary, but marked expansion of this species in profiles in northern Idaho, at Newman Lake, and at Fish Lake also denotes periods of fire sufficiently severe and frequent to destroy the climax forest and also temporarily check the development of a subclimax forest of western white pine (Hansen, 1939, 1943).

CLIMATE AND CHRONOLOGY

The maximum of glaciation in the Pacific Northwest probably occurred about 25,000 years ago (Antevs, 1945). After the ice began to retreat, an unknown period of time elapsed prior to organic sedimentation. Presumably sedimentation began first on those sites that were earliest freed of ice, or if located beyond the maximum ice advance, as soon as physiographic conditions became favorable. Thickness of sediments is no criterion for age, because of the great variation in thickness of sediments overlying the volcanic ash stratum, a common chronological marker. Upon the basis of the thickness of 60 Pacific Northwest sedimentary columns, the forest succession, and the position of ash and pumice strata, it is estimated that organic sedimentation on glacial drift or its chronological equivalent began on an average from 18,000 to 20,000 years ago (Hansen, 1945). Postglacial time is divided into 4 periods in light of the interpreted forest succession and climate (fig. 5). The first was moist and cool, and persisted until about 15,000 years ago. The second interval was one of increasing warmth and dryness, and is more or less arbitrarily considered to have endured until 8,000 years ago. The third period, from 8,000 to 4,000 years ago, was one of maximum warmth and dryness. It is during this period that the maximum of grasses and Chenopods-Composites was attained. The volcanic ash stratum common to so many Washington postglacial sedimentary columns is estimated at about 6,000 years, or about the middle of the warm, dry period. The fourth period, from 4,000 years ago to the present saw a return to cooler and moister conditions.

There is additional evidence for the occurrence of warm and dry climate during the Middle Postglacial. Profiles in the Puget Sound region disclose that western hemlock, a climax dominant, was unable to attain predominance until after the volcanic activity. In early postglacial time it was unable to replace lodgepole pine and Douglas fir because of unfavorable edaphic conditions due to sterile mineral soil. The incidence of warmer and dryer climate, especially during the summers, then arrested its development in normal forest succession, and it was not until the last four thousand years that it was able to expand and attain predominance (Hansen, 1941a). In the Willamette Valley of western Oregon, an influx of Oregon white oak (*Quercus garryana*), in the upper half of three sedimentary columns, replacing Douglas fir and lowland white fir, denotes the influence of the xerothermic interval (Hansen, 1942).

Further evidence for the occurrence of warmer and dryer climate from 4,000 to 8,000 years ago is shown by the fluctuation of Great Basin lakes, present salinity of certain lakes in the Great Basin, modern glaciers in the western mountains, pollen profiles of eastern North America, and postglacial climatic trends of Sweden and England. The present salinity of Owens Lake in California and of Abert and Summer lakes in southcentral Oregon is such that it need not have required more than 4,000 years for its development (Gale, 1915; Van Winkle, 1914). These lakes have lacked outlets in postglacial time, so their present low degree of salinity in-

dicates that their pluvial antecedents dried up, and the accumulated salts thereof were removed by wind or buried before the modern lakes came into existence. Antevs (1938, 1945) interprets this to mean that these lakes, as well as others in the Great Basin, dried up during the Middle Postpluvial (Postglacial) and then were reborn about 4,000 years ago with the advent of increased moisture. Allison (1945) has shown that Lake Chewaucan, antecedent of Summer Lake, stood at several tens of feet higher than the modern lake during early postglacial time. This indicates that Lake Chewaucan dried up during the warm dry period as did other lakes of the Great Basin. Subsequently Summer Lake was re-established in the lowest part of the basin.

It is believed that the modern cirque glaciers of the Sierra Nevada came into existence about 4,000 years ago, after a period of dryness which caused the remnants of the Pleistocene glaciers to entirely disappear (Matthes, 1939, 1942). Pollen profiles of eastern North America reveal that there was at least one period of warmth and desiccation (Sears, 1942; Deevey, 1943, 1944; Wilson, 1944). von Post (1933) believes that the postglacial vegetation history of Sweden depicts a period of maximum warmth which attained its maximum between 7,000 and 6,000 years ago, Godwin (1940) believes that postglacial forest succession in England also reveals evidence for a warm, dry interval about the same time.

CONCLUSIONS

Pollen analytical data from postglacial sedimentary columns in eastern Washington reveal evidence for the occurrence of a warm, dry interval between 8,000 and 4,000 years ago. Lodgepole pine apparently retreated southward into the Columbia Basin as the ice advanced, and persisted as the predominant arboreal species until well into postglacial time. Western yellow pine evidently did not retreat southward as a forest, because it is more abundantly represented near the top of the columns than the bottom in those sections that are removed from present-day yellow pine forests. The replacement of the early forests of lodgepole by yellow pine was arrested by warming and drying, which were more favorable for grasses, Composites, and Chenopods. The maximum warmth and dryness may have occurred about 6,000 years ago, near the time of volcanic activity recorded by a stratum of volcanic ash in many Washington sedimentary columns. Soon after this geologic event, yellow pine expanded to its maximum and predominance, a position which it retains today in the timbered Arid Transition area. This suggests a return to moister and cooler conditions in more recent time, perhaps beginning about 4,000 years ago.

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ANCIENT MAPLES OF THE CENTRAL WASHINGTON REGION

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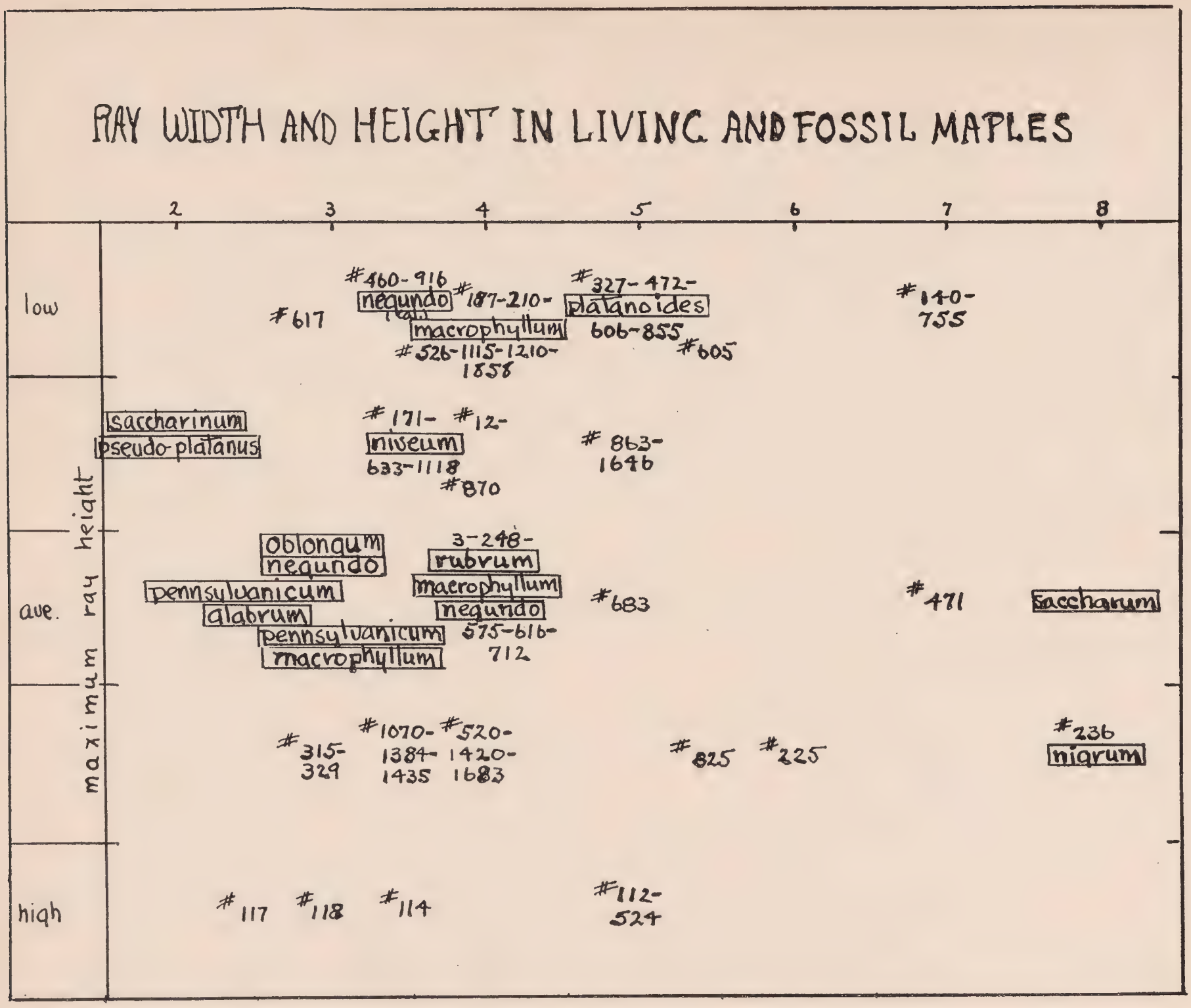
When I began work on the petrified logs of the general Vantage area some 13 years ago, it became apparent at once that maple-like woods are commonplace in the main (Vantage) raft forest and slightly less abundant in two rooted units of the Yakima Canyon. So widely do these woods range throughout the structural variations found in modern maples that little success has attended the efforts to assign them to nominal species. The extremes can readily be established but few hints exist as to the boundaries between them.

With this problem in mind it occurred to me that at least the variation could be shown if the specimens were to be distributed upon a chart indicating ray character. Upon this same chart modern species can be projected for whatever specimens are available to me. It is not implied that ray variation is the surest or best way to the specific determination of maple woods, extinct or living but that the rays are a feature that can be checked with some assurance in petrified wood sections.

It is of course difficult to guarantee that nothing but maple has been admitted to the chart. But all of these assumed maples have the general overall appearance of the genus and in addition have been checked for (1) strict diffuse pore arrangement, (2) homogeneous rays with even-sized, procumbent cells, (3) round to hexagonal, crowded intervessel pitting, (4) simple vessel perforations, (5) conspicuous spiral thickenings, and (6) parenchyma terminal but otherwise inconspicuous.

The woods of the general Vantage region have been accepted as the equivalents (in age at least) of the leaf and seed types established in the Latah (Spokane) and Grand Coulee floras.



Since the petrified forests occur in the uppermost 1000 feet—some 20 separate flows—of the lavas, while the two leaf floras have been encountered in the basal to middle series of the Yakima basalts, the woods are somewhat though not essentially the more recent (Upper Miocene). Whether or not they represent essentially the same species remains to be seen. Fortunately for this comparison, Dr. Roland Brown in Professional Paper 186 of the United States Geological Survey, 1936, part J, pp. 163-206 has contributed a paper on "Additions to Some Fossil Floras of the Western United States" in which he gives the maples considerable attention. On the basis of leaves and seeds he seems to have found four well-established types in the Grand Coulee and Latah floras:

1. *Acer bendirei* Lesquereux. Has as its modern counterpart *A. macrophyllum* Pursh, the common broadleaf maple of modern Washington forests. Grand Coulee.
2. *Acer glabroides* Brown. Has as its modern counterpart *A. glabrum* Torrey, the dwarf maple of present day Washington forests. Latah.
3. *Acer negundoides* MacGinitie. Resembles the modern box elder, *A. negundo* Linnaeus, no longer existing in Washington. Latah.
4. *Acer osmonti* Knowlton. Equals *A. saccharinum,* the silver maple of the eastern United States. Latah.

Upon the chart to which the modern and fossil maples have been referred for comparison, the rays have been assigned to five categories on the basis of maximum height and seven columns on the basis of maximum width. It is hoped that each specimen has been placed within one degree of the place it might properly occupy as the average opinion of a half dozen independent workers.

At a glance the chart indicates the presence of a broad-rayed hard maple

among which number 236 has been selected as the type. At the same time there is present a low and broad-rayed type (140-755) which may not have a living counterpart or may not represent maple at all. The whole chart shows a shift to the bottom for the fossils, which may indicate the presence of pseudo-maples. Numbers 114, 117, 118, 1384 represent the only (nominal) maple from the Roza Tunnel forest of Yakima Canyon and probably define a single species.

Quite consistently the fossil woods concentrate around the chart area represented by three different specimens of the modern broad-leaf maple. There is considerable certainty, therefore, that *A. macrophyllum* is in fact present as a type among the fossil woods. There is also a nucleus of fossil numbers about the position of the box elder and the existence of *A. negundo* in the fossil record is made more probable by the fine grain of number 520. To the extent that the chart is reliable, our western dwarf maple is less certainly represented and the silver maple, doubtfully.

It is conceivable that if fifty specimens were to be selected at random from modern maple woods, and projected upon the chart, the agreement of fossil wood rays and those of modern maples would be more positive.

Some of the Central Washington petrified forests have yielded (as yet) no fossil maples at all. Maple is exceedingly rare among all other western states collections I have reviewed. In the three forest units indicated, maple occurs with many other genera, hardwood and conifer, native and exotic. Only three of these are associated with the maple consistently enough to be present with it in all three forests—tupelo gum (Nyssa), red gum (Liquidambar) and Chinese "walnut" (Pterocarya) although there is a trace of persimmon (Diospyros).

I wish to express my appreciation for the loan of the Yale collection of modern maple sections from Dr. S. J. Record of that institution. I also owe thanks to Dr. Ralph W. Chaney of the University of California for use of the department's Hough collection of wood slides.

This has been a preliminary survey and conclusions based upon it may prove untenable. On the other hand, it may represent about all that can be said until these fossil woods have been treated in a monograph dealing with the genus *Acer*, including living and Tertiary forms, and wood, leaf, and seed counterparts.

AN EXPERIMENT IN EDUCATION:
THE ARMED FORCES COLLEGE TRAINING PROGRAMS

UNIVERSITY OF IDAHO[1]

H. E. LATTIG

Co-ordinator, Army Specialized Training Programs

Four separate service training units were established at the University of Idaho between April, 1942 and December, 1944. They were a Naval Radio Training School, an Army Specialized Training Assignment and Reclassification Unit, an Army Specialized Training Unit and an Army Specialized Training Reserve Unit. The ASTAR Unit was not considered when organizing this symposium because instruction was a very minor part of the program. Some of the trainees had as little as two days of instruction before being assigned.

In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in Your Military Training Program/s for Science Education; for Education in General.* To make this study for the University of Idaho committees were appointed to prepare reports on the several programs. Since the type of trainee and curriculum and the conditions under which the training was given varied widely in these programs, it was believed that, while there might be some duplication in the four committee reports, it was better to treat the programs separately rather than to combine them in one report. This did not apply to physical training, which was quite similar in all of the programs.

After some deliberation, the committees were given tentative outlines of the topics considered in the Washington State College article, the first in this series, with instructions to supplement or curtail them as seemed advisable.

In each committee, members were assigned topics. In some instances, two instructors worked on the same topic. After rough drafts were made by individuals, the committee met as a whole to discuss the results. In that way, the reports, at least partially, reflected the thinking of the committee as a whole.

It is unfortunate that, to date, none of the Army programs have been carried to fulfillment. A few trainees in each Army unit were able to finish the curricula to which they were assigned, but only a small percentage were assigned to tasks where that training could be put to best use. Furthermore, many of the Army trainees were disillusioned by ever-changing Army directives and lost interest before leaving their unit. In view of this, it is impossible to visualize the actual benefits which might have been obtained, had the AST been carried out according to the original plan.

The foregoing statement does not apply to the Naval Radio School. Here was a case where a definite plan was set up in the beginning and followed through to completion.

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[1] This is the second article in this series. Anyone wishing copies of this article or the other articles in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

FOREIGN AREA AND LANGUAGE PROGRAM

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INTER- INTRA-DEPARTMENTAL INTEGRATION

The Foreign Area and Language Program required close integration of the study of the area (elements of geography, history, economics, government, etc.) with the language instruction. It was difficult at first to achieve the necessary degree of cooperation, but after the opening weeks teachers of the languages and the related social studies worked together to produce fairly well coordinated programs. This required frequent conferences and a mutual understanding of objectives and procedures. Among the language teachers themselves, general meetings were held to review aims and techniques, while within the smaller faculty groups teaching the individual languages, coordination was achieved by daily contact with the senior instructor, the presence of "informants" at the general class sessions, visits by the senior instructor to the laboratory classes, and regular staff discussions. Certainly the example of this program gives hope for closer cooperation between departments. Unified programs, cutting across traditional departmental lines, are not only desirable, but definitely attainable.

The co-ordinator gave every possible aid to integration in the selection of teaching personnel, by suggestions, and by the encouragement of interdepartmental cooperation.

ADMINISTRATIVE PRACTICE

Adequate provision was made for salaries for regular faculty members. The pay allowed for native informants (who were regarded as untrained assistants rather than as teachers) was scarcely sufficient to draw men or women to Moscow from a distance. Since we are far from urban centers with a large foreign-born population, this did constitute a major problem. It was in large part by sheer good luck that we succeeded in bringing together an eager, alert, and devoted staff of informants.

FACULTY MORALE

Faculty morale was extremely high. All felt the stimulation of performing a useful wartime task. Regular faculty members enjoyed the unusual opportunity of teaching in an intensive program, under conditions that had never prevailed in college work. The program succeeded because they accepted these new conditions with enthusiasm, adapting teaching methods to the peculiar situations that arose.

The faculty had not only the enthusiasm, but also the preparation and experience necessary for the task. The senior instructors were language teachers of long experience; the informants, natives of the respective countries, were eager, alert, and intelligent collaborators. Their effective service indicates that in teaching, at least under close supervision, personality and possession of the subject matter have much more weight than formal training.

STUDENT MOTIVATION

We all feel that we never had a more interesting or more interested group of students. They were above the average in intelligence, and very serious in their approach to the training. Of course, added stimulus was provided in the beginning by the hope of advancement in rank, and the definite assurance that, if a commission could not be counted upon, these trainees would have the "inside track" when candidates for Officer Candidate School were to be selected. Shifting objectives, the fading hope of advancement, and the growing feeling that they would "return to the infantry" with their previous rank, hurt morale as the course progressed.

In the language program more than any other the personality and background of the students were important. The faculty knew the men as individuals through class contacts and frequent conferences. The fullest provision was made in planning and instruction for individual differences, and the special problems of trainees received careful attention. One example might be cited: trainees from the deep South required special guidance to overcome in the foreign language the loose enunciation and dipthongized vowels that are regional peculiarities of their English speech. The Classifications Officer cooperated in securing, early in the program, the transfer of men obviously not adapted to this sort of study. As a result, very few candidates were obliged to leave the program on account of poor grades.

That the students considered the instruction worthwhile was reflected in their hard work as individuals and as class groups.

SECTIONING

Division of sections according to ability and proficiency was followed in some cases. In others, the superior students were selected as "section leaders" to aid in conducting the class and in leading conversation outside the classroom. Students with less experience were given the stimulation of working under the leadership of the most skilled. Both plans have obvious merits. We do not believe that one is necessarily better than the other under all circumstances. As civilian enrollments increase again, the experience gained will be helpful in planning the sectioning of large classes. We feel it is demonstrated that in this field, for a certain type of work, students at various levels of attainment can profitably be grouped together.

Standardized placement tests were not used as a basis for sectioning. The estimate of the student's ability was determined by the use of varied written and oral exercises.

There were many examples of remarkable intellectual and social growth during the course. A few of the most satisfactory students had had little or no college training, but obviously a college background was, in the main, very valuable.

SPEED-UP

Considering solely the oral skills that the program was designed to impart, many trainees reached a considerably higher level in this nine-months course than could normally be attained in four years by a college major.

Stress was restricted to certain points. The *training* demanded to meet a specific military need is not the broad *education* we should provide under normal conditions. The principle of concentration in a single field of study is sound in language instruction, for it is necessary to live exclusively within the foreign atmosphere to attain real fluency. The principle could profitably be applied to regular language training programs.

The use of the foreign language in the dormitory and during leisure hours, informal conversations with the instructors, gatherings in the homes of instructors and informants, and participation in plays and song-fests all contributed to the students' progress.

CHECKS ON ACCOMPLISHMENT

Uniformity in grading was achieved within each language group by common written and oral examinations administered by the senior instructor. Discussion between the faculty members assured similar standards throughout the language program. Unfortunately , we could not measure our grading standards against those of other universities.

Only one type of test was used nationally by the War Department. Within its narrow limitations (it tested only auditory comprehension) it was interesting and fairly effective; we had, however, occasion to point out rather numerous weaknesses in the tests as administered. We have since made some use of the same sort of test in civilian instruction.

We believed the directives established precise objectives, but did not demand

absolute uniformity in methods. Language instruction must necessarily vary with the personality of the teacher. We all worked for the same end, but allowed for great differences in method on the part of individual teachers.

POST-WAR ADMISSION PRACTICES

We found that the number of years' study, or the number of credits accumulated, is no exact measure of proficiency. Experience outside college, such as that gained by actual use of the language at home or abroad, deserves consideration.

Evaluation of background and ability must be a rather slow process, resulting from an acquaintance with the student in the classroom and through conferences. Achievement tests are perhaps more just than credits as a basis for admission, but do not necessarily reveal the student's real ability. We should recommend that, if the achievement test be adopted as a basis for admission, the classification be subject to adjustment after the student has had the opportunity, over a period of weeks, to demonstrate his ability in class.

A year has now elapsed since the close of the Foreign Area and Language Program. The trainees are scattered all over the globe, but they continue to maintain close bonds with the University of Idaho. A mimeographed monthly paper keeps them in touch with one another, maintains a feeling of group solidarity, and fosters a continuing interest in language study. The numerous letters written excellently in the foreign tongue, and relating the experiences of the men abroad, offer the finest demonstration of the success of the experiment.

A.S.T. ENGINEERING AND PRE-PROFESSIONAL PROGRAMS

G. L. LUKE, Chairman, *Associate Prof. and Acting Head, Physics Dept., University of Idaho*
J. H. JOHNSON, *Prof. and Head, Electrical Engineering Dept., University of Idaho*
H. F. GAUSS, *Prof. and Head, Mechanical Engineering Dept., University of Idaho*
G. A. RIEDESEL, *Prof. and Acting Head, Civil Engineering Dept., University of Idaho*
E. TAYLOR, *Prof. and Head, Mathematics Dept., University of Idaho*
W. C. BANKS, *Assoc. Prof. of English, University of Idaho*
W. H. CONE, *Assoc. Prof. of Chemistry, University of Idaho*
A. G. CHAPMAN, *Instructor in Chemistry, University of Idaho*

INTER- INTRA-DEPARTMENTAL INTEGRATION

Early in the program a number of general orientation meetings were held, to which heads of departments and instructors directly concerned were invited. Such meetings were of value, and were supplemented by further discussions in the faculty meetings of the College of Engineering, and within the separate departments. The abrupt and frequent changes in the program prevented any extended planning for effective cooperation between the departments.

ADMINISTRATIVE PRACTICES

The assistance and cooperation of the co-ordinator with the department heads and teaching staff was excellent, and contributed substantially to the success of the program.

FACULTY MORALE

Everyone felt the urge of the emergency and no further stimulation was necessary.

To a large extent teaching loads in the AST program were excessive, and the outlines of the work called for more than could be done well by the students with their limited time for study; consequently, there was little opportunity for originality of experimentation in teaching practice.

STUDENT MOTIVATION

A comparison of student motivation in the AST with civilian education is quite difficult in view of the fact that the things which motivate us to action in the midst of war take on an entirely different aspect in peace-time. The students enrolled in the ASTP were of

exceptional caliber. This was the natural result of the rigid system of screening and selection of applicants used by the Army in recruiting its trainees for this program. This process of elimination was continued as trainees were found to lack interest or ability in advancing in the program. Because of the exceptional ability of these trainees, there was, in practically all instances, an exceptionally good display of cooperation and morale toward the material covered. This motivation seemed to come from a genuine patriotic impulse rather than from the selfish motive of obtaining a technical education at government expense. This was evident since many of these men were being trained in subjects outside their previous experience or personal ambition.

For effective teaching, the importance of understanding the individual's interests and problems was essentially the same in these programs as in civilian instruction. The alert, ingenious instructor would necessarily rise to the occasion and stimulate the student's imagination and challenge his interests, regardless of the situation. There seemed to be a very frank confidence and understanding between the trainees and the instructors in these courses. The men did not hesitate to express their opinions regarding course material, instruction methods, and purposes. This was in rather sharp contrast to the usual reluctance of civilian students to confide in the instructors on such things.

Unfortunately, it was not possible to assign some of them to courses and departments in which lay their major interests. This situation made it difficult to interest those particular students and secure the highest accomplishments. However, in most cases the spirit shown by the students was excellent; and with few exceptions they put forth sufficient effort to pass the courses.

It is hard to discern any important lessons born of the ASTP for student motivation in our civilian program which did not already exist. The stimulus of war, the expense-paid education, and rigid discipline will probably not be factors when we return to civilian education.

SPEED-UP

The ASTP was a war-emergency program and, in order to evaluate properly its accomplishments, it must be considered in this light. In such a situation saving time is most important. As a result, an effort was made to cut the nonessentials of a course to a minimum, and to crowd more courses, such as geography and history, into a curriculum which would train the soldier and, at the same time, shift the emphasis from broad, general applications to the more specific problem of winning the war. This resulted in what we regarded as a "speed-ed-up" program.

There is little that we can say in favor of similar "speed-up" procedure for civilian purposes. In most instances, the material covered in these courses and the time allowed for mastering of fundamentals was inadequate for proper professional training. The training in the ASTP Engineering program was obviously directed to produce a very specialized person in each particular field.

It is generally conceded by all those participating in the program, both faculty and trainees, that, on the basis of a comparison of the quality of the work done to that of normal civilian classes, no general "speed-up" in the learning process was evident. Any saving of time was at the expense of thoroughness, omission, or cultural training. There should result from our experience with the program some improvements of teaching techniques and presentation, and more careful evaluation of subject material. Nevertheless, anyone contemplating that, in the future, we are going to train capable professional people in two or three years is indulging in wishful thinking.

SECTIONING

Opinion among the faculty was divided as to the efficacy of arbitrary sectioning, but the program was discontinued before any selective sectioning into segregated groups of comparable background and ability could be carried out.

CHECKS ON ACCOMPLISHMENT

The fact that the soldiers assigned to the program were handpicked from various educational institutions made them, for the most part, a highly intelligent group, and easy to teach.

There was no difficulty in maintaining the same grading standards as those used in regular civilian programs, and the same type of examinations were used.

POST-WAR ADMISSION PRACTICES

The experience gained in handling Army students should be of value in planning post-war education. The students who spent one or two terms in the program should be given credit for their attainments, on the basis of the credit-hours in the week and the number of weeks in the term. In relating background to ability it was observed that the student who had had one or two years of training in an outstanding institution did not thereby manifest particular ability in the subjects he had taken. Nor did the fact of pre-Army education at a school of less prominence show that thereby the student's capability was below par. Thus the evaluation of a student's educational background in an effort to determine his ability would seem to rest more upon a properly designed achievement test than in assumptions based upon the particular schools which he had attended.

EDUCATION FOR CITIZENSHIP

The AST program comprised what might be termed end courses. That is, they were courses designed to qualify the student in the shortest possible time to undertake limited technical work. As such they were standardized and narrow. They could hardly be described as an effort to educate for good citizenship.

THE ARMY SPECIALIZED TRAINING RESERVE PROGRAM

H. E. PACKENHAM, Chairman, *Instructor in English, University of Idaho*
R. E. LOWNEY, *Asst. Prof. of Mathematics, University of Idaho*
D. H. ANDERSON, *Asst. Prof. of Chemistry, University of Idaho*
V. R. BAKER, *Instructor in Geology, University of Idaho*
C. L. WOODWARD, *Instructor in Physics, University of Idaho*
MRS. H. A. WINNER, *Instructor in History, University of Idaho*

INTER- INTRA-DEPARTMENTAL INTEGRATION

Organization and integration of courses for the ASTRP at the University of Idaho were accomplished with the advice and guidance of regular department heads without the appointment of additional department supervisors. Since practically all teaching was done by regular members of the staff, no administrative office except that of co-ordinator was created to carry out the teaching program outlined by the service command.

Departmental faculty meetings were called to discuss course content and methods, but more often methods and techniques were discussed informally at uncalled meetings. Such discussions often got quickly and frankly at the heart of a particular problem. Those who had been longest in the program were often able to give helpful advice and to strengthen the morale of teachers who became discouraged because the time allowance and contact hours were inadequate to meet course requirements or because some trainees, unwillingly involved in the program, made teaching difficult. Some specific conclusions resulting from informal discussions were that seventeen-year-old boys need more sleep and time for reflective thinking in order to function adequately in an academic program, and that military regimentation is not so conducive to a correct attitude toward learning as the freedom of normal academic life. Many college teachers in the military program faced a new problem in overcoming student indifference which, at least on the surface, is not so apparent in civilian teaching. On the other hand, teachers found in military classes many brilliant and eager students whose complaint was not that they had to take certain courses, but that they particu-

larly wanted some courses not provided in the inflexible military program.

Intra-departmental integration was urged in several directives from the service command. Such integration is normal at any time—in fact, inescapable in the relation and teaching of such subjects as physics, chemistry, and mathematics. One professor of chemistry pointed out a distinct advantage in that chemistry and physics were taken concurrently by ASTRP's. It is not often possible for civilian students to take beginning physics and chemistry at the same time because additional laboratory hours make it difficult to fit two science courses into a schedule, and because students are strongly advised not to take two "heavy" subjects at the same time. That credits for college work are not based realistically on the amount of study and time required is generally understood. If there is a real advantage in taking two interrelated sciences at the same time, perhaps some adjustments could be made in civilian practices.

English theme assignments based on course materials from history and geography helped students to assimilate these materials and to clarify their ideas. This practice should be valuable in post-war civilian teaching. Furthermore, English teachers have long contended that if teachers of other courses relied less often on false or true, multiple choice, or matching tests and more often on the essay type, with proper insistence on organization, clarity, and good usage, the work of the English Department might be strengthened.

Meetings were called by the co-ordinator to work out some of the problems of inter-departmental integration. For example, the number of hours of outside preparation to be expected for each subject had to be adjusted to the fact that military requirements are much more specific and exacting in some subjects and that time was limited.

FACULTY MORALE

There seems to be little doubt that the effect of the reserve program on the morale of the teaching staff has been somewhat detrimental. The uncertainty of the future value of what is learned by the student has an adverse effect on the attitude of the man towards his studies. There is a feeling in some quarters that the material presented will be of little value in the immediate future in Army life. It is to be expected that classroom work of those who hold this view will not be approached with enthusiasm. It is true that the program was set up to aid the war effort but the effectiveness of such aid is problematical.

Although the original ASTP plan was approached with some enthusiasm because all were eager to further the war effort, the results were to some extent disappointing. In the reserve program the results were still more disappointing. Learning is at best a somewhat slow process and material learned must be assimilated. The teacher, as the curriculum is set up, must devise methods to present the greatest amount of material to as many students as possible in the shortest time. Little or no time is allowed for a cursory excursion along the sidepaths to obtain an appreciation of the subject as a whole, or to begin to realize its value in the near future, to say nothing of its meaning in the larger life. Classes are heterogeneous as to ability and cultural and educational background. It is difficult to weld them into a unit for the complete discussion of exploitation of new ideas, without which no education is complete. Such practice can easily be justified in an emergency but it is very doubtful if that should be the rule in normal times.

STUDENT MOTIVATION

Many students in this program have had certain misleading impressions regarding the direct applicability of collegiate training in the serious business of war. The value of a mastery of the fundamentals of mathematics, physics, and chemistry has been readily recognized by most students. There were, however, many Army students who failed to recognize the importance which is attached to the study of history, English, and geography which may help them find a better place in the Army.

Many students believe that these subjects are definitely a part of the liberal arts, and have little connection with their training for war. Nothing could be further from the truth.

In geography, for example, many students had the impression that there was little to learn except place, location, and travel description. This arises from a national misconception of what geography is. However, when the geography of definite battle areas and theaters of war was presented they began to see the actual relationships between that study and the global conflict. Questions were raised pertinent to the geography of the battlefronts, which in turn aroused class interest, and as a result, with careful treatment on the part of the instructor, trainees began to see the relations between geography and a world at war. They became very much interested in a subject which to them had previously been unimportant.

The prospect of advancement in rank has been uppermost in the minds of a majority of Army students. Before enlisting in the ASTRP, students were led to believe that not only would they be getting an education at government expense, but that such training would put them in line for quick promotions once they went on active duty in the regular Army.

SECTIONING

It is generally believed that better training results would have been obtained had it been possible to assign trainees to class groups according to background in sciences, native ability and high school grades, but since all trainees were required to cover the same material this practice did not appear to be feasible.

No comparison could be drawn between students with previous college training and those with none since the former constituted a very small perentage of the whole.

SPEED-UP

Some people have criticized the Army program for the "speed-up" which was reported to have been practiced by some teachers in an attempt to include the material required by the authorities responsible for the program. This "speed-up" has not been "speed-up" in the sense that an automobile accelerates to get from one place to another in a shorter time. Rather, there has been a process of elimination of side roads which provide background for a rounded course. Also where a civilian taking freshman chemistry, for example, may work five problems illustrating the behavior of different gases under varying conditions of pressure and temperature, the Army students had to be satisfied with one or two problems which would include a number of variables other than the one being studied. When one considers that some twelve basic types of problems are considered in freshman chemistry, it is apparent that the civilians will be better prepared at the end of the term to face future problems in physics, chemistry, or for that matter any future work that depends on or is at all related to the ideas encountered in the class.

To summarize, the Army courses, especially in chemistry and physics, were not speeded up because there is a natural rate of absorption of material possessed by any group of college students which must not be exceeded if the teacher is to be successful. There has been specialization but not intelligent elimination since it has been impossible to cover the material outlined by the Army and it has been necessary rather to pare off material that one never should eliminate from a beginning science course.

As to the speeding up of the laboratory work, there can be no comparison between the Army and civilian chemistry courses since the time was limited to one two-hour period as contrasted with six hours a week spent in laboratory by civilian students. As a result the laboratory work was abbreviated and the longer type of experiment was eliminated in favor of the many-part-experiment that did not have to be completed in one period. This eliminated almost completely the quantitative type of experiment used to impress the concepts of valence, combining weight, and definite composition of chemical compounds. The same criticism applies to Army

physics courses but to a lesser degree since the course outlines provided for three hours of laboratory work per week for each physics class.

CHECKS ON ACCOMPLISHMENT

In certain courses such as history, the multiple choice type of test used by the Army for its term examinations is being used more and more for the four-week tests within the term. This type of test has certain obvious advantages for both students and instructors. However, it appears to be confusing to some trainees because of the seeming suggestions its carries. A few instructors feel that its form precludes testing those abstract but fundamental factors which underlie education; that it emphasizes memory rather than a sense of the whole; that it is too mechanistic. This type of test is a time saver for instructors and that has been an important item since the sections have been quite large and the teaching loads heavy.

Instructors have had an opportunity to comment on the tests administered by the Army, but it is not known whether these comments have in any way resulted in modification of the tests.

POST-WAR ADMISSION PRACTICES

A student who completed one full year of college before entering the armed forces will logically be placed in second year class work when he returns to college. However, since he will have been away from books and regular study hours for two, three, four, or more years, the old habits of study will be dormant. He therefore will be struggling with more than the textual information. It seems highly probable that some of these students will not be able to carry the work and that some special review or re-orientation classes will be necessary.

This situation will be multiplied many times with those students who have been accelerated or had a somewhat abbreviated course, such as offered in the ASTRP. It seems that for those who intend majoring in chemistry, for example, some review must be offered and probably in some cases it will be desirable, if not actually imperative, that the student repeat his first year of chemistry.

The question arises, will a student discover for himself that he is not adequately prepared to carry advanced work in time to re-register in the beginning course? Probably an examination and discussion with various staff members will reveal to the student the desirability of repeating his preliminary work.

Those electing a non-technical course upon returning to college may well receive a certain amount of blanket credit to be applied in lieu of certain electives, but should be required to fulfill the normal requirements for graduation in their chosen fields.

The same situation can well hold in the technical fields, but here probably less flexbility can be allowed. If a student is not prepared for sophomore work, even though his credits entitle him to sophomore standing, he may have to repeat some of his first year's work. This may even result in some credits earned in ASTRP being applied for social science or liberal-arts elective credits.

On the other hand, some recognition must be given the Army courses and probably a student who majors in a field with a science requirement can fulfill that requirement provided he has had sufficient time in the ASTRP or other program to get enough science credits to satisfy his major department.

EDUCATION FOR CITIZENSHIP

The ASTRP has had direct bearing upon citizenship values. In talking to many Army students it has been found that the vast majority of them felt that the program had educational value, namely, that education is just as potent a weapon in winning a war as are planes, guns, and tanks. One of the most outstanding factors that the program has brought to education, not only to Army students but civilians as well, is the fact that the United States can no longer afford to continue its policy of isolationism, but that we as a nation must learn to cope with the rest of the world.

It has been the belief of many that the ASTRP was too narrow in its cur-

riculum. Since many of the students had little or no interest in medicine or engineering, other subjects such as political science, economics, sociology, and psychology would have benefited them much more than did the pre-engineering curriculum.

Geography and history gave an insight into the causes and reasons for our global conflict; geography, at least, revolved about a knowledge of world affairs and recognized that the peoples of all nations face the problems of living together.

PHYSICAL TRAINING IN ARMY PROGRAMS

J. A. Brown, Chairman, *Acting Head, Physical Education Dept., University of Idaho*
E. Wohletz, *Asst. Prof. of Forestry, University of Idaho*
W. A. Ramsey, *Instructor in Physical Education, University of Idaho*

All men were required to take physical training one period each day, six days each week. They received one credit for a term's participation which is comparable to a semester's credit given regular students. This work has been considered as important and essential as any other subject taken.

Progress in physical fitness was evaluated at the beginning and end of each term. These tests have proved that progress in physical ability and fitness can be made even though there is comparatively little time devoted to the activities specifically covered in the tests. Results of tests show that twenty-five per cent of the boys were not able to swim when they arrived on the campus, but before their course was completed, there were no non-swimmers.

Results of the program show that in the post-war years tests evaluating progress should be given at properly spaced intervals as work progresses throughout the term as well as at the beginning and end of instruction. The value of a well-balanced program has been demonstrated since participants were not bored by repetition of unvaried tasks, acquired more vigor for academic work, and obtained vital relaxation.

NAVAL RADIO TRAINING SCHOOL

K. E. Hungerford, Chairman, *Director of Instruction*
Lee Gibson, *Control Room Operator*
Dee Cox, *Instructor*

DEPARTMENTAL INTEGRATION

The Naval Training School civilian instruction staff was set up as a separate department of the University. There was close co-ordination with the navy instruction staff and the various other Navy departments concerned.

The co-ordination within the civilian instruction staff was very close. This was necessary for several reasons: first, that twelve different instructors were teaching the same series of subjects to different classes in various stages of advancement; second, the course outlines of these subjects were being developed by the staff as the instruction progressed; and third, the final examinations and achievement tests were in the process of standardization. Co-ordination of instruction was promoted by committees assigned to develop the various courses of instruction and discussion of the courses in regular faculty meetings.

With the development of our course outlines there was room for experimentation and helpful suggestions, which were welcomed and were freely given by the entire staff. Frequent faculty meetings were held for the purpose of co-ordinating teaching activities and for hearing and discussing various suggestions on improvement of the program. A considerable latitude in free speech was allowed at these meetings and all opinions were considered. It is believed that these weekly meetings, in which nearly every part of each course was

very thoroughly discussed and evaluated, were a most important factor in contributing to the success of the school. Original teaching procedures and devices which proved beneficial were incorporated into the standard course outlines that were developed by special committees of instructors working with the Director of Instruction. This democratic procedure promoted the best efforts of each of the staff members.

FACULTY MORALE

The knowledge that the training at the Naval Radio Training School was an important contribution to the war effort was a definite stimulus to the faculty morale, even though long working hours and heavy instructing loads were encountered. Seeing men graduate and go directly to active duty made this feeling very real, especially when letters came back from these men giving helpful suggestions on the quality of their training.

Some sort of national award to the school of this type recognized as the best would have had a desirable effect on our faculty morale. An "esprit de corps" was present to a large degree, but some form of competition among the radio schools would have furthered this.

STUDENT MOTIVATION

With the exception of a few of the younger students who were unaccustomed to responsibility and some men who were sent to radio training against their desires, the students were seriously motivated by the realization that the radio training they received was fitting them for their place in the grim business of war. Special emphasis was placed on the actual responsibilities which a radio operator would encounter and just how the job fitted into the general picture. Since the men were at all times under military discipline it brought home the fact that they were training for war.

Advance in rating and consequent increase in pay was also a big motivating force for student effort. During the first year of operation any student meeting specific standards was eligible for an advance in his rating. Later only the upper ten per cent of a class could be rated regardless of the number meeting the set standards. Changes in the number of those from each class who received advancement and changes in the requirements for advancement affected this motivation considerably. When no restrictions were placed on the number receiving advancement, the motivation was very effective. However, when only a small percentage of each class received ratings, there was a noticeable let-down in effort.

The idea of keeping up with their class or outdoing their shipmates was a stimulus that helped keep individuals up to their best efforts. This element of competition was furthered by the use of a merit system whereby special liberties were granted to those classes attaining the highest goal. Special pennants were awarded classes with the best records in academic achievement. Individual competition was stimulated by rearranging the position assignments in the classroom on the basis of each week's code speed. In this way the highest scoring individual occupied the number one seat. Class segregation was determined on the basis of the individual's code speed, and a man was placed in a class which had a higher average code speed if he could raise his marks sufficiently.

STUDENT BACKGROUND AND SELECTION

Student background may have been to some degree a factor in predicting success; however, the most important requisite was the innate ability to acquire the particular skills that we taught. There were the anticipated number of misfits, the major number being due to inaptitude and a minority of failures being caused by lack of effort and dislike of the subject being taught. Some students had quit school to join the Navy and see action, then were sent back to school. Students of this type were difficult to deal with and military discipline was used only as the last resort.

Previous academic accomplishment served as a measure for predicting suc-

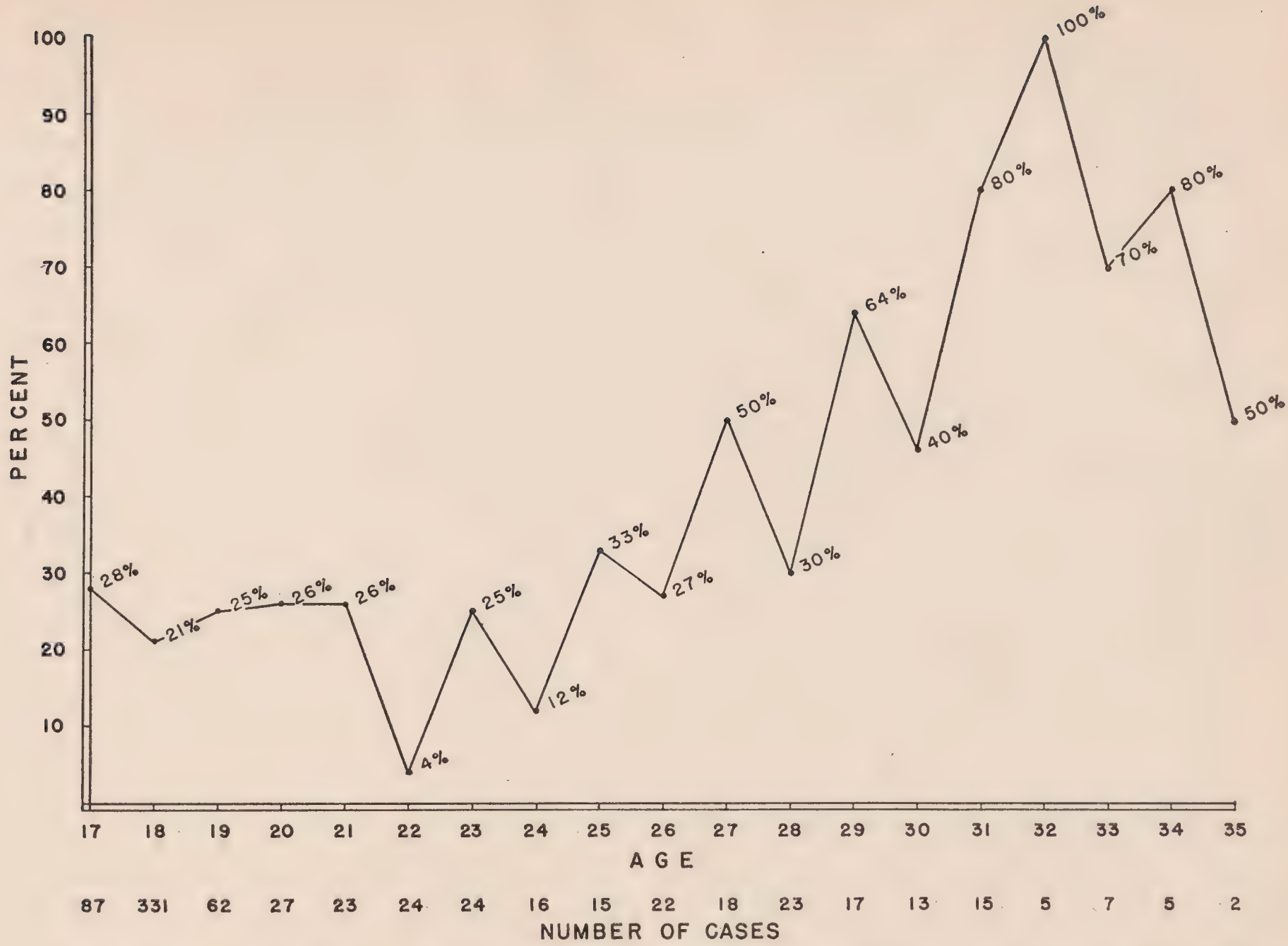


Figure 1—Percentages of students dropped or not meeting standards in code receiving in sixteen weeks class work, for age groups seventeen to thirty-five.

cess or failure in the study courses including operating procedure and radio theory. However, it proved to be less significantly correlated with success in the skill subjejcts—code receiving, code sending, and typing. It has been noted that a college graduate is just as likely to be a failure in code receiving as an eighth grade graduate.

Backgrounds of students varied considerably from eighth grade through college. Ages varied from approximately seventeen to forty years. The problems of administering classes of this sort, which numbered as many as sixty-five men, were increased whenever men who had considerable radio experience were assigned to school.

The consideration of age as a qualifying factor in the selection of men for radio operator training has some very interesting implications. In a study of nine classes (542 students) made by one of the writers[1] it was found that radio trainees between the ages of eighteen and twenty-four are more successful in developing the skills necessary for receiving radio code than those students either younger or older. All students were considered from each class excepting (1) those who had previously had some code receiving training and (2) those for whom no age records were readily available. The graph shows the percentages of students either dropped before completion of the course or not meeting graduation standards in code receiving within a period of sixteen weeks of class work. It should be noted that the eighteen-year-old group is much larger than any other and that the higher age groups are, therefore, less accurately indicative because of the smaller number of cases. However, it is felt that since the trend is so uniform, definite conclusions may safely be drawn. In considering the seventeen-year-old group, it should be mentioned that many of these men seemed to be dissatisfied with school routine, having quit school to enlist and see action.

The inevitable conclusion is that in similar training programs of an emergency nature, conservation of manpower and efficiency would best be ef-

[1] Lee Gibson

fected by setting an arbitrary maximum age limit for beginning students of no more than thirty years, since the average of groups thirty-one to thirty-five is seventy-six per cent failures or borderline cases.

SECTIONING

The skill subjects, code receiving in particular, caused more failures than all other subjects combined; hence all sectioning was done with this in mind. Segregation of some sort was necessary in teaching radio code. Two students without prior knowledge of code may finish the first eight weeks of the course as far apart in advancement as 0 and 20 words per minute receiving speed.

In some cases sectioning of students by their code speeds had obvious disadvantages. When a class of 180 men was divided in three parts on the basis of weekly code tests, those in the lowest section tended to develop a defeatist attitude and sometimes students would give up entirely. Another disadvantage was the fact that some students were shifted frequently and the students did not really become acquainted with their instructor or he with them.

There was no chance to segregate students on the basis of ability in their study subjects although such would have been desirable. The more advanced students in radio theory courses were given an opportunity to do work of a more advanced nature in their laboratory periods and were encouraged to make use of the library facilities which were offered.

SPEED-UP

There was definitely a speed-up of the radio training program over what would constitute the same type of material taught in peace time. In fact, with code receiving this was carried to such an extent that the extra hours of instruction did not seem to have the desired effect. In ordinary civilian life the time recommended for learning code receiving is approximately one to one and a half hours per day in periods of twenty to thirty minutes. The curriculum at the Navy school at one time called for as many as eight fifty-minute periods of code receiving per day. It was plain that the latter was considerably beyond a reasonable maximum. The course was later revised to include fewer hours per day of this subject, changing at different periods in the course. It is felt that the optimum results were obtained with three or four fifty-minute periods of instruction.

In connection with the radio theory instruction, there was both a speed-up in the instruction schedule and an elimination of material which was deemed unnecessary by the Navy. A total of seventy-eight hours of instruction was included in the thirteen weeks of theory. In this short period of instruction very little of the fundamental material was taught except that having a direct bearing on the operation of the specialized equipment which radiomen must actually operate. The entire course was geared to teach the operation of these pieces of equipment. This was necessary since in this short time only the very minimum could be taught and still cover the information required for graduation. In the laboratory section of radio theory an effective speed-up was developed by necessity. Due to difficulties in scheduling, only one consecutive hour each day in the week could be allowed for radio theory instruction, including both laboratory and lecture. Since the laboratory and shop work had to be given under these conditions, an effective system of charging out tools and equipment was developed in connection with the stock room. Here all of the equipment necessary for a class of thirty to forty men could be charged out within two or three minutes. This, of course, meant that the instructor had to plan his work carefully in advance with the stockman and that all equipment trays had to be fully made up before each class period. During some parts of the course this one-hour period was too short, while during other parts of the course it is felt that the one-hour period was sufficient. This, of course, depended upon the subject matter covered for the particular laboratory period, but it served to emphasize that with careful planning and preparation much could be accomplished during a one-hour lab-

oratory period. There was, also, the advantage that during the one-hour period excessive fatigue and lack of interest were avoided to a large degree.

CHECKS ON ACCOMPLISHMENT

Weekly tests were given in all subjects and these constituted a relatively reliable indication of a man's achievement. An unusual degree of standardization of instruction was possible inasmuch as the twelve instructors taught the same subjects. This uniformity was promoted by regular faculty meetings. Each instructor taught every subject in the curriculum for his class with the exception of radio theory, and he remained with his class throughout the entire course. It was found that the best teacher-student relationship could be maintained in this way.

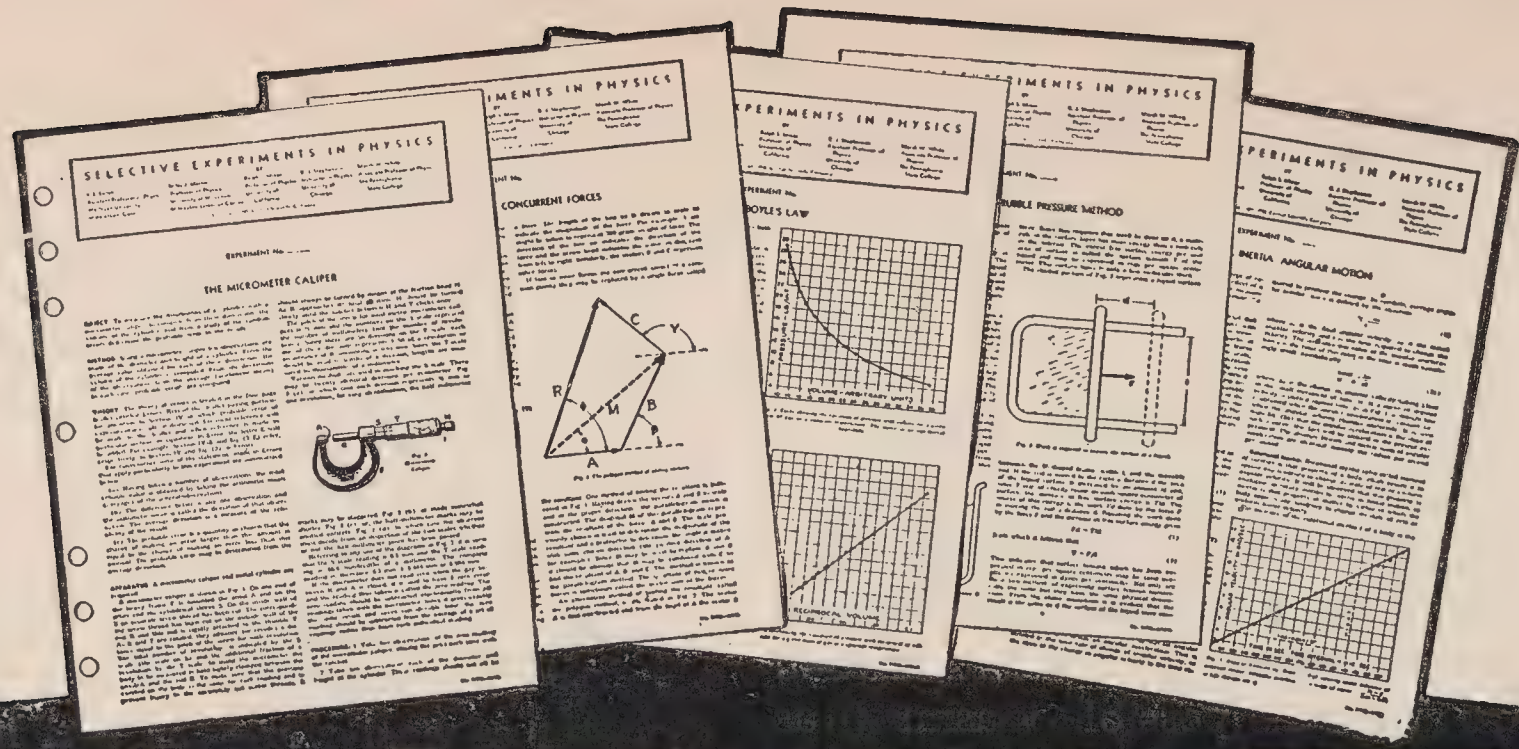
Questionnaires were used only to a minor degree. Suggestions from graduating classes as to the methods of instruction, type of examinations, and graduation standards were solicited. Letters from graduates after they had seen active duty also were requested. From these we obtained many valuable suggestions which were put into actual operation in the training program.

EDUCATION FOR CITIZENSHIP

In our speeded-up program of training for military service there seemed to be little time for an academic course in citizenship. However, a good serviceman is a good citizen and as a serviceman his responsibilities of citizenship are undoubtedly more keenly felt than those of a civilian.

A frequent application of citizenship training by the alert instructor was the mention of post-war jobs and how the training a radioman was receiving could be used after the war. More advanced students were guided in their extra studies into subjects known to be useful to a commercial operator. In this way a form of vocational orientation for post-war civilian life was exerted.

Radio communication as a hobby as well as a vocation was also considered. Nearly all of our instructors had been amateur radio operators in addition to their other activities and were prone to further the interest of their hobby which has had such an outstanding record during times of national and regional emergency. Radio training received at this school enabled a number of students to qualify for government operator licenses both amateur and commercial.



Selective Experiments in Physics

No. 71990

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NORTHWEST SCIENCE

February, 1945

Vol. XIX, No. 1

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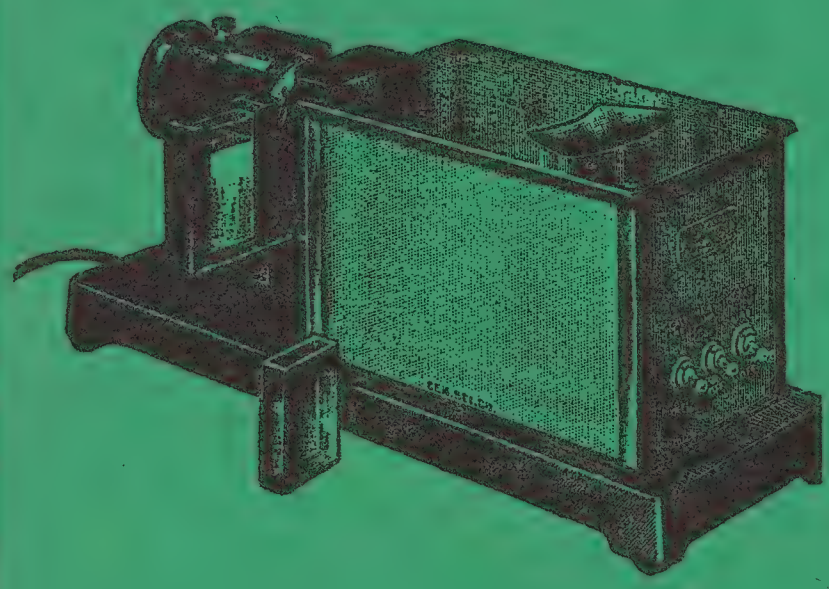

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NORTHWEST SCIENCE

Volume XIX, Number 1

1945

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Published quarterly by the Northwest Scientific Association

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL. XIX, NO. 1 FEBRUARY, 1945

Published April, 1945

Editor, W. R. HATCH, State College of Washington

To Our Readers:

NORTHWEST SCIENCE calls your attention to three articles in this issue, "AN EXPERIMENT IN EDUCATION: THE NAVY V-5 AND V-12 PROGRAMS, WHITMAN COLLEGE;" "AN EXPERIMENT IN EDUCATION: THE ARMY SPECIALIZED TRAINING PROGRAMS, FAR EASTERN PROGRAM, UNIVERSITY OF WASHINGTON," "AN EXPERIMENT IN EDUCATION: THE ARMY AIR FORCES TECHNICAL TRAINING PROGRAM, PREMETEOROLOGY 'B' PROGRAM, UNIVERSITY OF WASHINGTON." These articles are the third, fourth, and fifth in a series dealing with the military training programs with which these and other institutions in the Northwest have been preoccupied during the last two years. It is the purpose of these articles and of the whole series to evaluate these programs with an eye to discovering *What the Lessons in the Military Training Program/s were for Science Education; for Education in General.*

In this evaluation, however, it is essential that we be as critical and as objective as possible for it is quite as important for us to know which practices and methods cannot be adapted to civilian education as to discover those that may have application. It might also be emphasized that every effort has been made to enlist the most qualified persons on the several campuses and to handle all data as objectively as possible.

The following schools were invited to participate in this study: Central Washington College of Education, Eastern Oregon College of Education, Montana State College, Montana State University, Oregon State College, Reed College, University of Idaho, University of Oregon, Washington State College, Western Washington College of Education, and Whitman College. Of these eleven institutions, five, Central Washington College of Education, University of Idaho, Washington State College, Whitman College, University of Washington, and Montana State College, have already submitted articles. It is hoped that the other institutions will also wish to evaluate their experience. Comments organized into symposia or submitted individually in letters to the editor are solicited from any institution which has had experience with one of these military training programs.

Anyone wishing to subscribe to NORTHWEST SCIENCE ($1.00) or interested in obtaining reprints of articles appearing in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

The Editor.

COMMON RANGE FORAGE TYPES OF THE INLAND PACIFIC NORTHWEST

By R. R. Humphrey

Associate Range Conservationist, Soil Conservation Service, Wenatchee, Wash.

Differences in vegetation on a basis of growth form have probably been recognized since the time of our caveman ancestors. Even in prehistoric times, primitive man, without being definitely conscious that the distinctions he was making were a kind of classification, undoubtedly associated timber, grassland, or brush with certain food, shelter, and physical safety features. Recognition of these plant forms, and their association with the daily needs of existence, had a definite, intensely practical value.

Classifications as simple as these early ones have a practical and daily application in certain lines of modern endeavor. Grazing studies, for example, designed to evaluate forage resources for grazing purposes, generally require a breakdown of the vegetation into forage types. While such types are subject to changing pattern because of the effects of fire and grazing, each type is distinguished by certain growth form characteristics that distinguish it from all other types. A finer segregation based on floristic or taxonomic characters may be, and sometimes is, used, but a classification of this sort is more detailed than is usually necessary for designating the major types and, once adopted, opens the door to an almost endless number of types differentiated, not by a few growth forms, but by a relatively large number of genera or species.

Some of the more important forage types characteristic of the area here designated as the Inland Pacific Northwest are described in the paragraphs that follow. The statements largely represent the author's observations made during the five-year period from 1939 to 1944, and are based on recorded range survey data covering many thousands of acres. The area involved includes those portions of Washington, Oregon, and Idaho lying east of the crest of the Cascade Mountains, west of the crest of the Rockies, and north to the Canadian boundary. It extends south into parts of northern Nevada and California.

PALOUSE BUNCHGRASS TYPE

A large majority of the bunchgrass ranges in the Pacific Northwest are characterized by a mixture of such palatable perennial grasses as bluebunch wheatgrass[1], Idaho fescue, and Sandberg bluegrass (Fig. 1). Generally of lesser importance, and not always present, are big bluegrass, Nevada bluegrass, Indian ricegrass, needleandthread grass, junegrass and giant wildrye.

The wheatgrasses tend to be replaced on the sandier soils by needlegrass and Indian ricegrass and on gravelly soils in local areas by red threeawn. Giant wildrye may occur as scattered plants on north-facing slopes, but is particularly characteristic of alluvial valley fills. It is also a rather reliable indicator of the presence of surface and subsurface water supplies.

Other species of lesser abundance that characterize the type include such forbs as geranium, alumroot, phlox, balsamroot, hawksbeard, vetch, and lupine. Of these, geranium, alumroot, hawksbeard, and vetch go out under heavy grazing. Their presence, consequently, is usually a reliable indication of a range in good or excellent condition. As both balsamroot and lupine sometimes increase and sometimes decrease in abundance with deterioration of a range, these species are not satisfactory for use as indicators of range condition.

As the bunchgrass type deteriorates under too heavy grazing or improper management, the perennial grasses and forbs are replaced in varying degree by annual grasses and other weeds. Cheatgrass brome is usually the principal invader although in some localities an-

[1] Common and scientific names of plants listed are given on page Ten.

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nual fescues may be equally important. Annual forbs such as Russianthistle, Jim Hill mustard, fiddleneck, and tarweed may be abundant on severely deteriorated ranges.

On a great portion of the range that formerly would have been classed as bunchgrass, selective overgrazing of the palatable grasses has favored such unpalatable shrubs as sagebrush and rabbitbrush, with the result that over extensive areas sagebrush (or occasionally rabbitbrush) is now dominant. Utilization of the limited supply of soil moisture by these brushy species puts the grasses at an added disadvantage which markedly reduces the grazing capacity of these lands.

PONDEROSA PINE—GRASSLAND TYPE

Except in areas where timber is too dense to produce forage, many Northwest timber types are characterized by an understory of perennial grasses. Two general types predominate: the Palouse bunchgrass and the pinegrass-elk sedge.

In the lower ponderosa pine zone most of the dominants of the Palouse bunchgrass prairie extend upward into the timber and make the type highly productive from a forage standpoint. The predominating forage species in this type are usually bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass (Fig. 2). In addition, blue wildrye and slender wheatgrass are sometimes common. Arrowleaf balsamroot, yarrow, and butterweed are usually the most conspicuous perennial forbs. Either big sagebrush or bitterbrush may be locally abundant. The bitterbrush here, as in other forage types where it occurs, grows almost exclusively on the sandier soils. As neither sagebrush nor bitterbrush are fire tolerant, the presence of either species indicates an absence of fires during the lifetime of the stand.

Under overgrazing this type reverts to annual bromes and fescues and ultimately to Russianthistle, tarweed, knotweed, and other annuals, as does the typical Palouse bunchgrass type.

At higher elevations under ponderosa pine, with which may be associated western larch and Douglas fir, the sun-loving Palouse prairie grasses may be

Fig. 1. Palouse bunchgrass range near Heppner, Ore. The principal grasses are bluebunch wheatgrass, Sandberg bluegrass, and Idaho fescue. The scattered dead sagebrush plants may indicate a natural grassland range that was invaded by sagebrush which is now being driven out by the grasses.

Fig. 2. Timber type supporting grassland of the Palouse prairie type. The broadleaved forb is balsamroot. This type is highly productive of forage when properly grazed.

entirely replaced by pinegrass and elk sedge, species well adapted to growth in moderately dense shade (Fig. 3). Associated with the grass and sedge are usually such perennial forbs as arnica, butterweed, and yarrow. Shrubs such as creambush rockspirea, vine maple, serviceberry, and snowbrush occasionally comprise up to 5 or 10 percent of the forage.

As the pinegrass of this type deteriorates, the stand decreases in density, and annual hairgrass, annual bromegrass, and tarweed, knotweed, and other annual forbs replace the perennial grasses. Where big game animals are abundant, the snowbrush, which is grazed lightly or not at all by domestic stock, may be heavily browsed and completely defoliated during the winter and early spring by deer or elk. It dies out more rapidly than most shrubs under this severe use.

SAGEBRUSH TYPE

Extensive range areas in the Pacific Northwest that now have a big sagebrush aspect were at one time largely covered by perennial grasses. A gradual breakdown of this cover under poor grazing methods reduced competition for moisture, seeds of the sagebrush were trampled into the ground by the hooves of grazing animals, and the type changed from grassland to sagebrush (Fig. 4).

Other extensive areas, largely where precipitation was less or moisture conditions less favorable, were sagebrush-covered when the first white man saw the region. These true sagebrush climax types were generally composed of a mixture of perennial grasses, forbs, and browse. Bitterbrush was especially abundant on the sandier sites. The dominant grasses were usually bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, big bluegrass, junegrass, and, on local spots moister than average, giant wildrye. Forbs that were always present, though comprising only a minor portion of the total plant cover, included species of loco, lupine, vetch, hawksbeard, butterweed, balsamroot, and Indianwheat.

Most of this natural sagebrush range with its associated palatable grasses has undergone various degrees of deterioration and today it is often difficult to

Fig. 3. Climax stand of pinegrass and elk sedge beneath ponderosa pine and Douglas fir, near Lake Chelan, Wash. Because of the rather low palatability of pinegrass this type produces less forage than the density and vigor of the grasses would lead one to expect.

distinguish such areas from sagebrush areas that were formerly grassland. In both types, as the perennial grasses have thinned out under heavy grazing, the stands of sagebrush have become thicker and cheatgrass brome or annual fescues have taken the place of the original longer-lived and more valuable grasses and forbs.

Where soils are shallow and rocky and may be wet for several weeks in the spring, big sagebrush is replaced by smaller species, usually either threetip sagebrush or stiff sagebrush. Areas of this sort are generally locally referred to as scablands or, if limited in extent and fingerlike, as swales. They do not support thick stands of wheatgrasses or other large bunchgrasses, but do provide a habitat well suited to the smaller Sandberg bluegrass which persists with the sagebrush under long continued heavy grazing, though with reduced density.

Rabbitbrush or snakeweed may partly or wholly replace the sagebrush on severely deteriorated sites. Rabbitbrush, in particular, may be dominant on former cropland areas in the early years after abandonment. In time, most of the original rabbitbrush plants on these cropland areas die without much replacement by younger plants of the same species. The sagebrush, on the other hand, is well suited not only to initial invasion of bare areas, but to continued reproduction in competition with the older plants and may increase until eventually checked by competition from invading perennial grasses.

Rabbitbrush may persist indefinitely, especially under heavy grazing use, on shallow soils or on sites too alkaline or moist for sagebrush or most perennial grasses. It is frequently abundant on valley fills, especially those that have been deeply gullied. The giant wildrye that formerly occupied such sites has been largely or entirely driven out by heavy grazing or a combination of heavy grazing and lowering of the water table due to gullying.

BITTERBRUSH-GRASS TYPE

Bitterbrush occurs over extensive portions of the Pacific Northwest, particularly on droughty sites, from areas of

low rainfall where precipitation is about seven inches up to the ponderosa pine type (Fig. 5). The shrub is particularly well adapted to growth on sandy soils and over much of its range it is the characteristic plant on soils of this type. Under heavy grazing it usually persists after the accompanying perennial grasses have been driven out.

Although bitterbrush is often heavily browsed, it is grazed by domestic stock rather lightly when it comprises a large proportion of the vegetation and the range is conservatively stocked.

Although both bitterbrush and sagebrush are highly susceptible to killing by fire, sagebrush tends to become reestablished more quickly, with the result that occasionally recurring fires may increase the stand of sagebrush at the expense of the bitterbrush.

Perennial grasses comprise most of the understory vegetation on bitterbrush ranges in good or excellent condition. The species most often present include bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, while on the sandier sites Indian ricegrass, needlegrass, and sand dropseed commonly occur in the mixture. Such forbs as yarrow, phlox, and lupine are also frequent components of the type. Because bitterbrush sites are droughty, the type deteriorates rapidly under heavy grazing and the perennial grasses are replaced by annual bromes and fescues which markedly reduce the value of the type for grazing purposes.

PERENNIAL WEED TYPES

Vegetation types with a perennial weed aspect are not common in this area. Likewise, they are usually rather limited in extent and in most cases represent local deterioration from a more highly productive type.

One perennial weed type sometimes encountered within the Palouse bunchgrass climax area results from selective grazing in bunchgrass areas containing a moderate amount of balsamroot. This forb, less palatable than the grasses, increases in density until the area loses its former grass aspect and can be classed as a perennial weed type.

A second type with a perennial weed aspect may result from deterioration of a bunchgrass range containing scattered

Fig. 4. Sagebrush range in poor condition near Orchard, Idaho. Perennial grasses occur only as scattered specimens between the sagebrush plants.

plants of balsamroot, biscuitroot, wild buckwheat, loco, and lupine. Here, also, as the grasses are weakened and reduced in numbers by too heavy grazing, the perennial weeds increase sufficiently to change the aspect.

In mountain meadows false hellebore often grows in dense stands. Normally, however, these stands are too small to class as separate types and would be included in the meadow of which they form a part.

An additional mountain type, occurring largely on the west slope of the Cascade Mountains and on the east slope also to some extent, is the bracken fern type (Fig. 6). Bracken is low in palatability and shows a tendency to increase under heavy grazing. It also may rapidly invade newly burned-over or cut-over clearings.

Because of its characteristic of invading burns and other disturbed areas bracken is often a component of another perennial weed type occurring in timber—the fireweed type. Fireweed is a prolific seeder and for several years after a fire may produce so dense and vigorous a stand as largely to exclude all other vegetation except those species able to grow in rather dense shade. It commonly persists for several years but is usually ultimately replaced by timber species.

Common camas is frequently sufficiently abundant to give mountain "parks" a perennial weed aspect in the early summer. Later in the season the plants die down and the aspect then usually changes to one of perennial grasses or, on severely grazed and deteriorated areas, to annual weeds, principally Douglas knotweed and tarweed.

ANNUAL WEED TYPE

Annual grasses or annual forbs are characteristic of run-down ranges under a wide range of climatic conditions (Fig. 7). So typical are they of deteriorated areas that, with few exceptions, a range with an abundance of either annual grasses or forbs may be assumed to have deteriorated from a perennial type. Usually, though not always, these annual ranges will be in either fair or poor condition.

Annuals commonly invade following destruction or weakening of the original

Fig. 5. Bitterbrush type along south shore of Lake Chelan, Wash. The tall grass is bluebunch wheatgrass. Forbs discernible are balsamroot and lupine.

Fig. 6. Logged off area with a perennial weed (bracken) aspect. A few perennial grasses, not abundant enough to characterize the type, are present.

vegetation by recurrent fires or improper grazing methods, or after abandonment of lands once plowed. On the deteriorated grazing lands annual bromes (usually cheatgrass) or fescues and tarweed take the place of the perennial species. A continuation of the practices that permitted the annuals to enter will in time drive out all the perennials, though Sandberg bluegrass may persist for a long period under severe misuse.

Under long continued use, particularly by sheep, or as a result of smut or adverse climatic conditions, the annual grasses may thin out sufficiently to permit the entry of such annual forbs as fiddleneck, Jim Hill mustard, and Russianthistle. The mustard tends to be erratic in behavior, in that it occurs in exceptional abundance in certain years rather generally on run down ranges, then may be present only sparingly for several years on these same ranges, only to flare up again when conditions again become favorable. Russianthistle and fiddleneck, on the other hand, are more stable. Though they usually serve as reliable indicators of extreme range depletion and eroding sites, they normally do not occur intermingled with the annual grasses as does the mustard.

On the bare ground of abandoned plowland areas Russianthistle is almost invariably the first plant to appear. After about a year it is normally replaced by either annual bromes or fescues unless heavy grazing and active erosion prevail. When mustard is intermixed with Russianthistle, the mustard usually persists well into the annual grass stage.

Annual grass ranges are generally soon invaded by rabbitbrush and sagebrush, later by a few plants of squirreltail followed by a gradually thickening stand of Sandberg bluegrass. Reestablishment of the bluebunch wheatgrasses may be delayed for 30 to 50 years or longer, depending on severity of erosion, presence of a seed source, and grazing management.

On open, parklike areas and dry meadows at high elevations tarweed and Douglas knotweed are the principal forbs on deteriorated ranges. These have replaced the perennial grasses (largely tufted hairgrass) that formerly predominated. Such annual grasses as annual hairgrass and pullup muhly are very much in evidence but do not make up a greater density than on ranges of this type in better condition.

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED

Alumroot, *Heuchera* sp.
Arnica, *Arnica cordifolia*
Arrowleaf, *Hofmeisteria pluriseta*
Balsamroot, *Balsamorhiza* spp.
Balsamroot, arrowleaf, *Balsamorhiza sagittata*
Biscuitroot, *Lomatium* spp.
Bitterbrush, *Purshia tridentata*
Bluegrass, big, *Poa ampla*
Bluegrass, Nevada, *Poa nevadensis*
Bluegrass, Sandberg, *Poa secunda*
Bracken, *Pteridium aquilinum pubescens*
Bromes, annual, *Bromus* spp.
Buckwheat, wild, *Eriogonum* spp.
Butterweed, *Senecio* spp.
Camas, common, *Camassia quamash*
Cheatgrass brome, *Bromus tectorum*
Cherry, wild, *Prunus* spp.
Dropseed, sand, *Sporobolus cryptandrus*
Fescues, annual, *Festuca spp.*
Fescue, Idaho, *Festuca idahoensis*
Fiddleneck, *Phacelia* spp.
Fir, Douglas, *Pseudotsuga taxifolia*
Fireweed, *Chamaenerion angustifolium*
Geranium, *Geranium* spp.
Hairgrass, annual, *Deschampsia danthonioides*
Hairgrass, tufted, *Deschampsia caespitosa*
Hawksbeard, *Crepis* spp.
Hellebore, false, *Veratrum californicum*
Indianwheat, *Plantago purshi*
Junegrass, *Koeleria cristata*
Knotweed, Douglas, *Polygonum douglasi*
Larch, western, *Larix occidentalis*
Loco, *Astragalus* spp.
Lupine, *Lupinus* spp.
Maple, vine, *Acer circinatum*
Muhly, pullup, *Muhlenbergia filiformis*
Mustard, Jim Hill, *Sisymbrium altissima*
Needleandthread, *Stipa comata*
Needlegrass, *Stipa* spp.
Phlox, *Phlox* spp.
Pinegrass, *Calamagrostis rubescens*
Pine, ponderosa, *Pinus ponderosa*
Rabbitbrush, *Chrysothamnus* spp.
Ricegrass, Indian, *Oryzopsis hymenoides*

Fig. 7. Annual weed type composed almost entirely of cheatgrass brome. The dead sagebrush plants have been killed by grasshoppers that stripped the plants of their leaves and a portion of their bark.

Rockspirea, creambush, *Holodiscus discolor*

Russianthistle, *Salsola pestifer*

Sagebrush, *Artemisia* spp.

Sagebrush, big, *Artemisia tridentata*

Sagebrush, stiff, *Artemisia rigida*

Sagebrush, threetip, *Artemisia tripartita*

Sedge, elk, *Carex geyeri*

Serviceberry, *Amelanchier alnifolia*

Snakeweed, *Gutierrezia* spp.

Snowbrush, *Ceanothus velutinus*

Squirreltail, *Sitaniun hystrix*

Tarweed, *Madia exigua*

Threeawn, red, *Aristida longiseta*

Vetch, *Vicia* spp.

Wheatgrass, bluebunch, *Agropyron spicatum* and *A. inerme*

Wheatgrass, slender, *Agropyron trachycaulum*

Wildrye, blue, *Elymus glaucus*

Wildrye, giant, *Elymus condensatus*

Yarrow, *Achillea lanulosa*

NYSSA WOODS OF THE PACIFIC NORTHWEST MID-TERTIARY

GEORGE F. BECK
Central Washington College of Education, Ellensburg, Washington

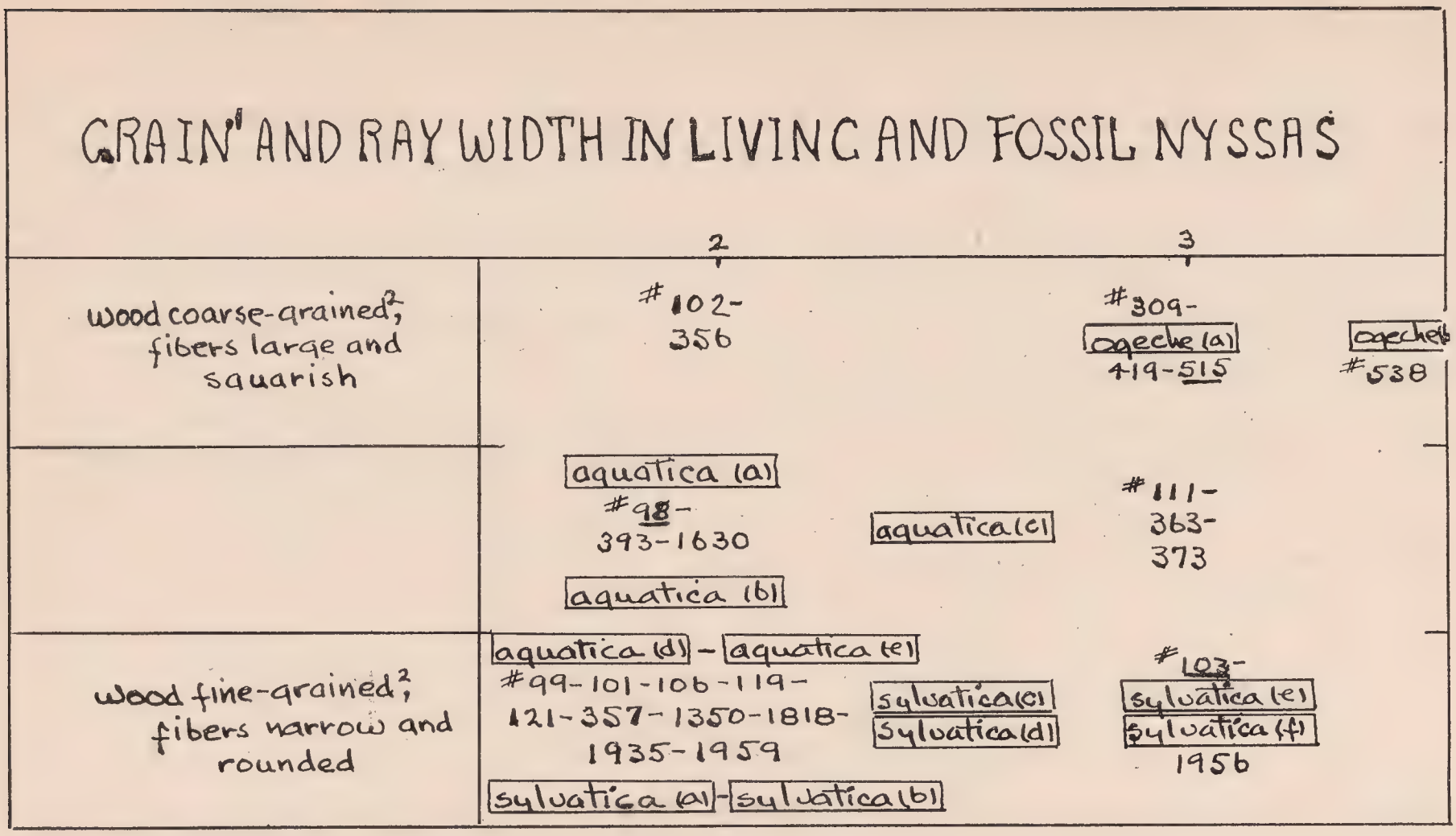
The nyssa gums are one of the modern genera of trees most certainly present among the petrified woods and forests of the Pacific Northwest. Almost every collection from the mid-Tertiary of this region contains a few specimens of typical tupelo or sour gum. These are fine-grained woods which to the unaided eye may be mistaken for conifers. Under the microscope they reveal (1) fine, many-barred perforation plates, (2) small, oval to oblong horizontal intervessel pitting, (3) crowded, 1-3 seriate, heterogeneous rays, (4) fine, multiseriate, horizontally aligned field pitting, (5) more or less conspicuous diffuse parenchyma and (6) strictly diffuse, radially aligned pores. There is a considerable variation in the degree of heterogeneity of the rays, and in the diameter (and shape) of the fibers (tr), as observed from specimen to specimen.

Existence of nyssa-like woods among fossil remains has been suspected for about three generations (since 1870) and Dr. F. H. Knowlton has given Heer credit for the first recognition of such wood (Nyssidium). This leaves only two fossil hardwood types with a longer standing—Goeppert having reported an oak-like wood as *Quercites* (*Quercinium*, Unger) in 1839, and Unger having described a sycamore-like wood as *Plataninium* in 1842. The present citation seems to be the first for the genus definitely as a wood, at least on the Pacific Coast.

Nyssa leaves and stones, however, have been known for some decades. Credit for the recognition of a leaf in the Pacific Northwest apparently should go to Dr. Ralph W. Chaney of the University of California who reported nyssa leaves from Bonneville in his publication on the flora of the Eagle Creek formation (20). Soon afterwards both leaves and seeds of the genus were encountered in the generalized Latah beds of eastern Washington and adjacent Idaho. Comments upon these were made by E. W. Berry (34), pp. 121-122:

"All the (stone) specimens collected are preserved as casts in the clays, and they show various degrees of flattening. The type (N. hesperia) came from the Latah formation at Spokane, Wash. These stones are very much smaller, more rounded at the ends, and with fewer ribs than *Nyssa magnifica* (Knowlton) Berry of the Latah formation. They are associated with the leaves described as *N. knowltoni* Berry in both the Latah and the Payette.

"But two American Miocene species based upon leaves are known—the one mentioned above and a second from the Eagle Creek and other Miocene beds in Oregon, (and the leaf



1818, 1956, 1959: Pendleton, Oregon (Miocene?)
1350-1359-1630-1935-1938: Payette Region, Idaho (Miocene?)
All others: Central Washington (Russell Flora) Miocene
1. Size and shape of wood fibers.
2. In cross section.

species, *N. knowltoni*) may represent the foliage of the same botanic species which furnished the *Nyssa* fruits described (as *N. hesperia*)."

Somewhat more recently Dr. Roland Brown has discussed the nominal species of *Nyssa* in the Pacific Northwest (36) saying, page 184:

"The two leaves figured here show that occasional pointed lobes or teeth on leaves of this species indicate a probable relationship with *Nyssa aquatica* Marshall, of the southeastern United States. There being no other detectable leaf species, it is assumed that the characteristic seeds called *N. hesperia* belong to *Nyssa knowltoni*."

Despite this apparent tendency to reduce the nyssas of the Pacific Northwest mid-Tertiary (Miocene) to one nominal type, the woods show the variation exhibited by the three common species of present day eastern America —*N. aquatica* Linn., *N. sylvatica* Marsh., and *N. ogeche* Marsh. We have, therefore, the choice of one extremely variable Miocene species or as many or more species as represented in eastern America today. Each of the above mentioned modern species has its typical counterpart in the fossil woods appropriately marked (italicized).

In the chart the living and fossil types are compared as to ray seriation, and fiber diameter and shape. Both living and fossil woods show considerable variation in ray heterogeneity which has not been evaluated successfully for this report.

As projected upon the chart, the living specimens represent examples from the Hough series belonging to the Department of Paleobotany of the University of California, or examples of a series taken from various portions of the range of the living genus in America. I am indebted to Dr. Ralph W. Chaney for use of the former and to Dr. I. W. Bailey of Harvard for the latter.

The chart seems to indicate that the fossil woods provide the counterparts of all three modern American species of *Nyssa* with a more general grouping in the area (lower left) where *N. aquatica* and *N. sylvatica* overlap. There is at least one good example (515) of the *ogeche* type and it is here cited as the

type for the genus as a whole, as well. The types for the other modern species are indicated as numbers 98 and 103. A slight departure from these three types (upper left and center right) may represent error in placement or inclusion of additional extinct species, or greater variation on the part of the ancient wood types.

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AN EXPERIMENT IN EDUCATION: THE NAVY V-5 AND V-12 PROGRAMS

WHITMAN COLLEGE[1]

In the larger symposium to which the colleges and universities of the Northwest are contributing the question that is being asked of all institutions is *What were the Lessons in your Military Training Program/s for Science Education; for Education in General.* This evaluation was made for Whitman College by a panel of members of the faculty and administration of Whitman College, chosen to represent both the required and elective curricular areas of the Navy training programs, as well as their over-all administrative aspects. In this way, it is believed, a representative cross-section of faculty opinion and evaluation has been obtained.

The panel met as a group several times to discuss general policies and procedures in preparing the symposium, but the separate contributions were written largely independently of each other. It has seemed best, therefore, to present the material in this fashion, for a number of reasons, not the least of which is the value of preserving the individual contributions as complete units, so that differences as well as agreements of opinion may be all the more conspicuous. This method inevitably produces some unevenness and diversity of presentation, but it is the belief of the panel that it also provides, more accurately than any other method of presentation, a truly representative cross-section of Whitman faculty opinion.

THE NAVY V-5 PROGRAM

LAWRENCE H. BUSSARD, Coordinator and Instructor in Code and CAR, Navy V-5 Program

Assistant Professor of Modern Languages, Whitman College

and

WALTER L. RILEY, Coordinator Navy V-5 Program

Assistant Professor of Political Science, Whitman College

The nature of the V-5 Program must be well defined before any attempt is made to assess its value as a possible source of contribution to the amelioration of the present liberal arts program, with a view to adjusting this latter so that it may better qualify to meet the specific needs of post-war education.

[1] This is the third article in this series. Anyone wishing copies of this article or the other articles in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

The objective of the V-5 training was to prepare men to react automatically to a large number of specific conditions to be encountered in a single field: aviation. With the possible exception of Meteorology the program relied mainly upon memory training to prepare the student to cope with situations demanding a practical knowledge of the functioning of aircraft (emphasis in the V-5 Program was laid on actual flying of aircraft—not the theoretical aspects of flight). Two factors, then, make a clear-cut separation between the fundamental nature of the V-5 curriculum and the goal of the liberal arts program: (1) V-5 prepares for narrow specialization, (2) V-5 relies mainly upon memory training.

Aside from the above considerations there are certain other features which tend to differentiate V-5 from ordinary college procedures to such an extent as to make them incompatible. The V-5 trainee had each hour of his day planned and overseen by teachers or officers. He could exercise his initiative and individuality only within a very narrow scope. Such a narrowing of the student's freedom is basically unacceptable to the American philosophy of education, and resembles more the European system.

If the fundamentals of V-5 training can scarcely be considered as potentially capable of offering major ideas for application in the broader college field, still, there are certain minor points in which it excels, particularly in the question of procedure. The V-5 training accomplished certain things of detailed nature whose applicability to teaching in general should not be overlooked:

(1) Extensive and effective use of visual aids:

a. Projectors and films used for most subjects. These films were carefully prepared and clarified many difficult points for the cadets, particularly in the field of meteorology.

b. Daily weather maps.

c. Cartoon poster material (changed daily) displayed in classrooms to emphasize various points.

d. Books consisting of a series of cartoons illustrating various phases of a subject.

e. Extensive use of cartoons throughout various serious texts (prepared by the Navy).

(2) Use of mechanical equipment directly in connection with all phases of theoretical discussion: airplane parts, navigator's equipment, calculating apparatus, etc.

(3) Plentiful standardized equipment placed in the hands of each student (no student hampered for want of sufficient and adequate texts or apparatus).

(4) Strict system of obligatory attendance in all classes. This is somewhat inconsistent with civilian tradition but it has its advantages.

(5) Supervision of teachers and teaching methods by the Civil Aeronautics Authority (a question scarcely arising in the case of experienced and academically qualified college teachers, but a point to be considered).

(6) Frequent testing and grading were called for weekly. This seems impossible for college work, but it suggests that a more frequent testing of students tends to increase both their interest and their efforts.

(7) Objectivity in testing was obtained through a system whereby the teacher had nothing to do with the final examination. He neither prepared it or graded it.

(8) Cadets falling below a passing grade were restricted, i.e., forced to spend week-ends in their quarters studying. (It is unlikely that any parallel method of force could be applied outside a military system.)

In brief, it appears that certain details of the V-5 Program could be profitably studied and perhaps in some cases advantageously adopted for use in the liberal arts program, but that its basic principles are too foreign to the objectives of college-level training to be viewed as of any value in the broader field of higher education.

THE NAVY V-12 PROGRAM

CHARLES J. ARMSTRONG, Director, Navy V-12 Program

Assistant Professor of Classics, Whitman College

The most outstanding benefits of the Navy V-12 Program for postwar liberal education are, it appears to me, three in number.

First, the V-12 Program, itself an adaptation of the liberal arts curriculum to the needs of war, specifically the training of Navy officer candidates, has afforded proof to the College of the vitality of the liberal arts, and corroborated belief in their value and significance for the postwar period. Training in responsible leadership, in intelligent thinking, in the mental disciplines of precision, analysis, synthesis and perspective, has always been the aim of Whitman College, and this kind of training has also been a basic principle of the V-12 Program. The courses of the Program have, with few exceptions, been those normally offered by the College, and the educational philosophies developed by Whitman over a period of years have needed no significant modification. The primary importance of this single fact for the future of liberal education can hardly be overemphasized.

The second important lesson of the V-12 Program is its demonstration of the value of the fully-prescribed curriculum as opposed to the freely elected program. The Navy has been interested in certain very definite, short-term objectives, it is true, but the implications of this method in application to the more far-reaching objectives of postwar liberal education are obvious. V-12 curricula are predominantly scientific, but within the framework of each curriculum the pattern is that of liberal education, and, as a result of the very definite objectives of each, an integration has been achieved such as was seldom true of pre-war college curricula. This, together with the better student motivation deriving from these same objectives, has produced, despite, or, perhaps, because of the acceleration in quantity and emphasis upon quality, more student work and better than average scholastic results, without any lowering of academic standards.

Finally, the V-12 Program in Whitman College has added impetus to the development of the student counselling and guidance program, and has clearly demonstrated the importance of such a program, even more fully developed and carefully planned, for the postwar period—one which will be geared to the needs both of returning veterans and of younger students, whose preparatory education has been subjected to the stresses of war time. The contribution to the success of the V-12 Program, from the point of view of student motivation and attainment, made by an effective counselling program, which was centered in the office of the V-12 Director, but which was augmented and expanded by other interested faculty members in student conferences, and implemented by the intelligent use of diagnostic and measuring tests, has been, we believe, a large one. The increased requirements of the V-12 Program have put upon students a more stringent necessity for the proper use of time and effective methods of study than ever before, and the counselling program has therefore been chiefly directed toward these ends. It may well be that the success of the liberal college in meeting the needs of the future will hinge upon the effectiveness of its counselling program.

There are in addition many lesser advantages accruing to the College as a result of its wartime experience, which can be only briefly noted here. The use of audio-visual training aids, developed by the Navy far beyond the limits previously imposed on colleges by lack of resources, has increased student interest in subject matter, and produced more work in less time. New techniques of testing and classification have been worked out, and valuable experience gained in the addition of some new courses to the curriculum or the adaptation of existing courses to new requirements. Innovation in college procedures has acquired a new respectability as a result of the frequent necessity for speed and dispatch in making decisions and

achieving results. This will undoubtedly prove salutary in meeting the many as yet unknown demands of the postwar period.

In sum, it appears to me that this college's experience with the Navy training programs will in many ways improve its ability to undertake its future tasks.

THE NAVY V-12 PROGRAM

DOUGLAS V. MCCLANE
Registrar and Associate Professor, Whitman College

This Registrar faced the opening of the Navy V-12 Program with combined apprehensions and satisfactions. The immediate satisfactions were represented in the knowledge that Whitman College was undertaking a very important special job in the service of the nation, and that its particular war assignment provided opportunity for the College to serve as it was best fitted to serve, namely, to maintain its traditional pattern of liberal arts coeducation and at the same time operate strictly in accordance with the Navy's wishes.

Any apprehensions centered around the question of how the Navy V-12 Program would affect the gyroscope in a registrar's office machinery. The V-12 was not long in operation before we realized that we were dealing with a program which in many respects approached our vision of perfection.

Most certainly there were adjustments which had to be made—extra office assistance had to be secured; the total number of individual records to be kept increased, but only directly with the increase in new enrollments the program occasioned; some extra records of scholastic performance had to be kept; et cetera.

But totally the dispatch and efficiency of the V-12 Program, which is directly felt in a record keeping office, has offset entirely in end results the effect any additional work the Program has caused the Registrar's office.

There are many small satisfactions, such as the following:

(1) The fixing in advance of carefully determined classifications of study which when once set up on the registrar's books seldom change. In the cases of "regular" V-12 trainees the Navy has prescribed curricula; in the cases of "irregular" V-12 trainees, a carefully conducted counseling program in the V-12 director's office helps to bring about study classifications in which there is seldom occasion to make changes.

(2) The establishment of a speeded-up registration procedure encompassing many efficiencies.

(3) The experience of dealing with young men who are in every respect college students, but who are impelled to be completely responsible in their relationships with the college administration.

But more important than citing factors and techniques which make work a pleasure is a scrutiny of some of the results of the V-12 Program as revealed by the registrar's records.

(1) Enrollment figures have increased. Not that there has been in the College *during any one trimester* a markedly increased number of students, but the turnover of V-12 trainees and the addition of a summer trimester have meant that during the academic year 1943-1944, for example, there was a 23.9% increase in total enrollment over the academic year 1942-1943.

(2) The average per-hour student load has increased. During the winter and spring trimesters of the academic year 1943-1944, 365 V-12 registrations averaged 18.6 hours per trainee. Over the same two trimesters 654 civilian registrations averaged 13.8 hours per student. The combined Navy and civilian per hour student load was 15.5 hours. In short, V-12 trainees carried an average student load of 4.8 hours per man heavier than civilian students carried.

(3) A comparison of grade point averages of V-12 and civilian students dur-

ing the winter and spring trimesters of 1943-1944 is as follows:

Composite grade point average, both trimesters: V-12, 2.489; Civilian, 2.680.

It would seem that the higher grade point average attained by civilian students is attributable most largely to the fact that the average civilian load, as explained above, was 4.8 hours less than the average load carried by Navy men. Further, the subject matter in Navy curricula, which includes a preponderance of science, without question is more difficult than that contained in the classification of the average civilian student.

(4) It is a matter of pride to the College that the academic achievements of the men in the V-12 unit have constantly improved. During the first three trimesters of the V-12 operation the grade point average of the unit improved respectively as follows: 2.368, 2.444, 2.500.

(5) Scholastic failure at the end of each trimester on the part of V-12 trainees has ranged from 15% to 20% of the unit. This is a somewhat higher percentage of failure than is normal among civilian students. Civilian students are admitted to Whitman selectively and the method of selection of V-12 trainees means that they too, in the main, are a select group of students. It seems accurate to assume that civilian and Navy students are of essentially the same competence, but that the higher percentage of failure on the part of Navy men is caused by three factors: (1) V-12 trainees carry heavier loads; (2) a few seamen are unfitted for V-12 training or are assigned to the Program against their personal wishes; (this was more true of the early days of the V-12 Program than of the present) (3) the method of separation for poor scholastic performance is rigid. A special V-12 Academic Board has been established, one duty of which is to review carefully the scholastic achievement of each man. This Board has devoted long hours to its work and has carefully recommended for separation from the Program each man who seems to lack the mental ability and personal qualifications of an officer.

(6) With only two or three exceptions the courses offered by Whitman College in the V-12 Program correspond closely to those normally offered by the College. Beginning November 1, 1943, they, with the exceptions noted, have been offered to Navy men and civilian students alike. All courses completed by Navy men have been credited towards the individual's A.B. degree, and a number of V-12 trainees have been or will be graduated by the College. Only minor modifications in degree requirements have been necessary in graduating them under the Accelerated Degree Program of the College.

(7) A few faculty additions have been necessitated during the operation of the V-12 Program, but in some cases these were replacements of personnel which had been called to war service, and in other cases they are part-time instructors. The average teaching load of the faculty has increased, but not in every case. In a very few cases at first some instructors carried as much as 22 hours of teaching. These teachers gradually have been relieved, and at present full-time instructional loads range in the majority of cases between 16 and 19 hours, with science teachers in the main carrying the highest number of contact hours.

In a longer and more comprehensive report many more facts could be given and conclusions drawn by the registrar and his staff concerning the V-12 operation. Space limits cause this report to be inadequate. However, it is hoped that this brief summary will convey the impression that from the registrar's point of view, and also from the institutional point of view, our experience with the V-12 Program is highly satisfactory.

THE NAVY V-12 PROGRAM

LEO C. HUMPHREY

Dean of Men and Associate Professor of Chemistry, Whitman College

At the termination of the spring, 1945 trimester, Whitman College will have accumulated two years experience with the Navy V-12 Program. In this short time, the Program has left its mark on our institution. While its impact has been felt most keenly in the science division, our whole institution has been influenced considerably by the presence of Navy officers and service men on our campus.

Within the limits of the writer's experience, the presence of the V-12 Program on our campus has been of great value. It has given us an acute consciousness of the fact that we are making a substantial contribution to the war effort. It has been inspiring to realize that our curricular offerings do have a practical and significant use in the business of war, and it is evident that we have realized considerable success in communicating to our students enthusiasm for the subject matter in our courses. In other words, it has served as an incentive to our faculty to do better teaching. The necessity for pointing toward a definite objective has also brought us the satisfaction of working toward a common goal. Departmental lines have been forgotten, and a greater cooperation between different divisions of the institution has resulted. Every member of our V-12 faculty has endeavored to assure himself that our V-12 students received the best possible academic training. We have given more individual instruction than ever before. Some new techniques, made available through the Navy, have been utilized to make our instruction more effective. We have scrutinized even more closely the study habits of our individual students, and as a result, failures in our courses have been fewer than we have experienced heretofore. It is hoped that this increased efficiency in teaching will carry over to the post-war period.

There is no question but that the discipline to which V-12 trainees must adjust themselves has been of great personal benefit to the young men in this program. They have been taught to keep appointments punctually, and to maintain regular hours. They have been forced to get sufficient sleep. Politeness and regard for others have been stressed in a manner that could be accomplished only under military regulation. These instructions have had a great influence on their behavior in the classroom. Absence and tardiness have been very rare, and attention in class has been much improved. It is hoped that trainees will retain the fruits of this discipline when they return to civilian life.

Presence of the V-12 Program on our campus has created some problems, also. Because of the nature of the Navy curricula, there has resulted an unusual emphasis on scientific training. Consequently, the faculty and facilities of our science departments have been burdened to the limit. This burden has been felt most keenly in our Departments of Mathematics, Chemistry, Physics and Physical Education. From the point of view of the liberal arts objectives, this influence has made us somewhat lopsided.

Since nearly all of our housing facilities have been utilized by V-12 students or by women, it has been necessary for our upper-class civilian men to live in private homes off the campus. These students have felt keenly the lack of a spirit of unity, and it is hoped that this situation may be improved soon.

During the past three years many articles have appeared in the newspapers, popular magazines and professional journals concerning the so-called "accelerated program" under which the various military programs have operated. Acceleration in education, especially of the technical variety, was represented as a war-time necessity. Many enthusiasts have advocated a continuation of accelerated education even after peace has been declared. It is the opinion of this writer, however, that as

soon as possible the accelerated program should be discontinued. For a short time it is possible for a student to carry a heavy academic load, but it appears evident from our experience that many of the benefits of education both curricular and extra-curricular, are lost when he is compelled to accommodate himself to a concentrated high-pressure educational program. Likewise, faculty members cannot give their best under such a program.

THE NAVY V-12 PROGRAM

WILLIAM L. HUTCHINGS

Associate Professor of Mathematics and Physics, Whitman College

After five terms' experience teaching in the V-12 Program I am left with profound doubts as to whether or not the V-12 and other similar armed forces training programs will influence to any great extent post-war education. Except for the general war-time speed-up, elimination of vacations, and fairly heavy credit hour load, the V-12 Program is very nearly a standard introductory technical course. The Program is highly condensed and heavily weighted with mathematical and physical courses.

As regards the mathematics and physics course, the Program is very well integrated both as to course content and sequence of courses. Detailed curricula such as those of the V-12 offer one possible suggestion for post-war college planning, particularly for returning service men. Many departments could profitably spend time in outlining detailed curricula and sequences of courses designed for specific goals. Too little thought is put into proper sequence, and even content, of courses.

Experience in the V-12 Program has convinced me that the general "speed-up," both in number of courses taken per term and the elimination of vacations in the war-time college program, should have no place in post-war planning. I have invariably observed, with few exceptions, a slackening of interest, with a consequent drop in morale, in the majority of V-12 trainees during their third and fourth terms. This I judge to be primarily due to a fatigue factor. Time is still a paramount element in education.

In a curriculum loaded with mathematics and physics courses, the general success of the V-12 trainees offers one more piece of evidence of the utter falsity of the general pre-war student attitude, "I can't do math and physics." Of course it must be remembered in this connection that success in these courses is required for further advancement to officer training of the V-12 trainees and hence a powerful motivation factor is present, which is lacking in other cases.

In connection with the technical courses, particularly physics, experience in V-12 leads me to one other conclusion. The traditional laboratory procedure in first year physics courses needs complete recasting. Where large groups of students are handled in the laboratory, nearly always the procedure degenerates to a cut-and-dried repetition of standard experiments. The student enters the lab, makes certain measurements, fills in a prepared form and leaves—all too often with no idea of what he has done or why he has done it. Nothing could be more foreign to the spirit of experimental science. Even at the first year level, physics departments should provide facilities, at least for good students, to experiment on their own initiative.

I doubt whether the extreme technical bias of the various war training programs should or will carry over to post-war practice. While planners should remember the horrible vacuum of physical training and knowledge, found in the products of our educational system at the start of the war, and should try to prevent a repetition, any attempt to "high-pressure" students into taking too much technical training will defeat its own ends.

THE NAVY V-12 PROGRAM

PAUL J. JACKSON

Associate Professor of English, Whitman College

In dealing with ideas and general problems, it became evident to me at an early stage that the general intelligence of V-12 trainees was high. There were definite points, however, at which their thinking became inadequate, and these points correlated quite obviously with the extent of their vocabulary. There were many concrete instances in which an individual trainee, after he had acquired some new words and with them new ideas, changed his opinion as a result of increased understanding.

By comparison with civilian students, the average V-12 trainee is woefully deficient in his knowledge and use of grammar. There is only one other language skill in which he is still worse: spelling. This spelling deficiency offers the clearest clue, I believe, to the basic reason for the unusual weakness of the average male high school graduate in writing. Freshmen men exhibit ability in speaking in contrast to their ability to write clearly or correctly. Evidently, the writing situation has never been made convincingly real to them by their teachers or by their environment generally, whereas they have come to realize that the ability to speak effectively is of real value. As a result, their ability in writing is still frequently at about the sixth grade level. The emphasis which the Navy put upon skill in writing offered a new and real motivation for the first time to many of the trainees.

Coupled with the deficiency in written composition was a low reading ability, both resulting from identical causes: the world of the written word has too long remained unreal and unfamiliar to male students. This deficiency in reading skill has been, I believe, the major contributing cause to the difficulties which trainees have encountered in all their college subjects.

Lastly, may I note that there was apparent a notable difference in achievement between those determined to complete successfully the V-12 Program and become officers, and those to whom V-12 was not an adequate motivation. Some of those students who entered with notably poor training in English improved phenomenally because of an almost fanatical determination, a determination seldom observable in peacetime. In spelling, however, few students made much improvement; learning the ability to spell must start much earlier than college.

THE NAVY V-12 PROGRAM

NORMAN E. RICHARDSON

Assistant Professor of Philosophy, Whitman College

Because of the amount of time allowed to certain students for electives in the V-12 Program, one of its most important features, many of the trainees were able greatly to broaden their education. A small percentage of these students took work in the philosophy department —some because they wanted to, others to fill in the blank spaces on their schedules. Since ours is a small college the instructor was able to get to know these men rather well; and thus whatever these suggestions lack in breadth may be made up for in terms of depth.

While there was some free time for electives the main emphasis of the program was on the development of specific skills. By concentration on these areas the Program was able to speed up the acquiring of these techniques. One of the more general conclusions which is being drawn from this experience is that this speeded-up approach can be applied to the whole liberal arts program. Another interpretation and one which I believe to be much more valid, can be made. The liberal arts education attempts to give the student perspective

and to develop his ability to use his mind. This cannot be speeded up—it is a slow maturing process. The development of technical skills, on the other hand, can be learned much faster after a student has had this liberal education, and much better learned at the hands of the company for which the student goes to work. With the possibility of large government subsidies for technical training the colleges should be on their guard against selling their liberal arts education for a mess of technical training.

A second conclusion is that many of the students are interested in trying to integrate the knowledge which they are getting in various courses and departments. While mine was a selected group of students, it did include many of the highest academic averages, and for this reason I believe that this concern of theirs should be given real consideration. From the point of view of the teaching of philosophy it suggests that we should turn from the problem approach to the presentation of whole systems. From the point of view of education as a whole it suggests that there is a real need and demand for an integrated education, a thing which we have sadly lacked ever since the elective and vocational approaches came in with their consequent disintegration.

Another conclusion should follow immediately on this one—the practical concern of the students. They want something which will "pay off". Many of them are thinking in purely financial terms, but some of them are thinking in broader and longer terms. They want something which will help them as individuals to live better and fuller lives, and through them, the society of which they are a part. This does not mean a demand for the progressive or experimental approach in our education, but rather an approach which will point out the practical and contemporary applications of the broader ideas of our intellectual and cultural heritage. Most of the teaching of the social sciences has come to a safe stop far before contemporary issues. What these more mature students want is an objective presentation of the overall ideas which have been tried throughout man's history, and an application of them to the contemporary scene. All of which means that our post-war education must get off its secondhanded basis, roll up its sleeves, and get into the contemporary scene, not as the advocate of any particular program, but rather as the means of presenting alternative programs and their historical consequences. Education must become a resource of democracy, not an escape from it.

One final conclusion, and this from the point of view of all the students with whom I came into contact, especially those found in philosophy classes merely to fill out their schedules. There is a serious lack of motivation on the part of all students. The immediate job before them, training for the winning of a war, served in most cases to carry them through the programs. But there was no long-term motivation, whether it be political, ethical, or religious. Coupled with this I found a cynicism with regard to man, individually and collectively. As the result of the combination of these two attitudes there was an increasing tendency to hand over to someone else the problems which do not immediately concern themselves. Here, it seems to me, is the fertile soil for some sort of fascism. It does not at all mean that we should embark on a program of indoctrination, which would simply supply the seed for which the soil is so well prepared. Rather, the harder job is ours, that of providing, by democratic methods, some sort of basis for democratic motivation. To me this means a re-emphasis on the social sciences, and on those general principles which have been the basis for man's social life: ethical ideals, law, and religious belief. But how are these to be taught? Surely they cannot be taught in the so-called "objective" manner which we have been using. Instead, we as teachers must come to a greater appreciation for the role of these elements in our culture, and a greater understanding of them, first. Then, by trying to develop a similar knowledge and appreciation in our students, democratically, we may be able to do the job that is ours today.

THE NAVY V-12 PROGRAM

FREDERIC F. SANTLER

Associate Professor of Modern Languages, Whitman College

Much has been said about the so-called G. I. language program. Recent magazine issues abound with articles describing in glowing terms the advance in language teaching based upon the innovations and experiences of teaching modern languages in the armed services. By and large, however, the method of language instruction in the Navy V-12 Program at Whitman College remained in most aspects, with slight modifications, a continuation of procedure followed in pre-war days.

Whereas normally in language study the course begins with a study of grammar and progresses via courses in reading, writing, and conversation to courses in literature, it seemed practical, from the very onset of the Navy Program, to look to the course in Scientific German or Medical German as the terminal course. German in the hands of a V-12 student was not a humanistic discipline, but a tool in the furtherance of his study of the medical science. Because of this, some of the text books used for civilians had to be replaced with new ones, specifically chosen for the purpose of attaining a so-called reading knowledge. Conversation was by no means eliminated but its scope had to be revised to fit the new demands. Since cooperative tests were used in term examinations, some comparison between civilian and Navy achievements was possible. I realize, however, that such a comparison based upon standardized tests may be questioned as to its validity since the objectives were not entirely identical. The time factor must be considered. Whereas the civilian beginning language courses met five time a week for fifty-minute sessions, all Navy courses were three-hour courses. Naturally, in spite of the selectivity of the Navy V-12 complement, industry alone was not sufficient to offset the loss of two weekly class sessions. Sometimes V-12 students, after having taken the first or second trimesters of German, had to skip the third and fourth in order to acquaint themselves with the contents of the terminal course, i.e., Medical German. But this is a war program and such forced acceleration must be viewed in terms of the existing emergency. With all these disadvantages, hard work on the part of the instructor and students succeeded in achieving results which compared favorably with civilian progress.

Innovations in the method of instruction were limited to new text books, the use of phonograph records for conversation and the use of a German as a native informant, plus many unscheduled conferences with V-12 students. In all other respects the Navy Program remained a civilian program, conducted in the same manner and graded by the same standards.

THE NAVY V-12 PROGRAM

RONALD V. SIRES

Assistant Professor of History, Whitman College

The men of the V-12 unit at Whitman College seemed to me to be somewhat above the average in ability. Among them were a number of especially bright persons and a few who could be called slow thinkers. From the standpoint of ability they were a rather satisfactory group of people to work with.

I question very much the validity of the statement that the V-12 Program was a true college program. In the first place, the hours did not fit into the picture of general college procedure. It may seem to the military mind correct to force people to arise at six A. M. or thereabouts but doing so has no necessary connection with the gaining of a liberal education. I have watched otherwise healthy young men come to class week in and week out in a depressing state of fatigue, and wondered why it

was necessary to have it so. A number of weeks of such a regime could not enable the young man in question to be intellectually alert. From such a situation involving many more than one student, unusual achievements in the field of history could not be expected to arise. Few indeed were the men who did anything more than the minimum requirements, and it should be unnecessary to remark that many did less.

A word ought to be said about the attitude of V-12 men toward the work in history, not considering, of course, the question of their physical energy. In general, it may be said that they have been only slightly interested in history for its own sake, but that when the historical material helped to cast light on a specific problem of the present, either national or international, they showed a very definite interest. This was especially true with regard to class discussion. I am not able to say, however, that the interest shown in this connection carried over into more extensive reading. The V-12 Program does not seem to me to encourage extensive and thoughtful reading.

It should be remarked that throughout the trimesters devoted to the study of the historical origins of the present war it has been possible to present the material in an open-minded way. This thought has run like a thread through the courses—wars are not generally the result of the wrongs committed by one country or group of countries. Occasionally it was possible to sense opposition of some student toward such a point of view in the class room, but in general the students have reacted satisfactorily to it. It is my opinion that if this line of approach really "took," the men concerned will have fewer adjustments to make in their thinking in the period following the war.

The V-12 Program should furnish the country at large with a number of clues as to the kind of higher education that should be offered after the war. My first suggestion along this line is that educational opportunities should be made available to all qualified persons, whether former members of the armed forces or not. As the new generations come on, there will be many worthy young people who cannot afford higher education, and our policy should make it possible for them to get the education they need and want. I believe also that while the government makes funds available for former members of the armed services, the nature of the education to be offered and the methods of instruction by which it is offered should be decided by the individual institutions concerned. These educational opportunities should not be offered on the basis of "acceleration," as conceived in the first part of the present war. The system should be based on the assumption of the right of the student to think for himself, and should provide ample time for him to mature in the field of general education and in some field of specialized study. It may be hoped that the continuance of the policy of educational freedom may be to some extent a defense against the growth of Fascist tendencies in thought in this country in the post-war period. The tendencies in that direction will be more than sufficient in any case, and it would be statesmanlike to maintain an educational policy that would encourage the growth of independence of thought.

AN EXPERIMENT IN EDUCATION:

THE ARMY SPECIALIZED TRAINING PROGRAM FAR EASTERN PROGRAM[1]

UNIVERSITY OF WASHINGTON

By F. H. Michael
Associate Professor of Far Eastern History, University of Washington

In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in your Military Training Program/s for Science Education; for Education in General.*

The Army Specialized Training Program of Far Eastern Language and Area Studies at the University of Washington started in July 1943 and lasted for nine months until April 1944. The program formed a part of the great scheme of language and area programs distributed over many universities in this country, of which a smaller number consisted of Far Eastern programs. The unit on the campus consisted of 125 army students who were to be trained in Japanese, Chinese, and Korean language and areas respectively. For the last three months we had an additional number of fifteen army students who were to receive short brush-up courses in Far Eastern languages (mostly Mandarin, Chinese and Cantonese) and area courses.

An excellent detailed outline of the general objectives and the methodology of the program was provided for us by the army. This was followed as closely as possible. It required that the student should receive in language training a "complete command of colloquial spoken form of the language" meaning "the ability to speak the language fluently, accurately, and with an acceptable approximation to a native pronounciation" as well as "a practically perfect auditory comprehension of the language as spoken by natives." In the area study, the student was to get acquainted with the geography, history, and contemporary institutions and culture of the region. Special emphasis was to be given to the understanding of actual situations which the student might later encounter rather than the memorizing of past events. In a detailed list the Army provided us with the particular facts to be studied as, for instance, vegetation, animal life, natural resources, slogans, political sentiments developed for historical reasons, food and drink habits, dwelling, folkways, impact of local government on daily life, with a thorough knowledge of local government organizations and services, popular amusements and sports. These subjects, mentioned here at random, indicate that the students were to receive an understanding of actual living conditions in addition to the historical, political and geographical background of the countries. A study of contemporary history was "to give the trainee an understanding and appreciation of the scope and importance of the war in which he is engaged as a soldier in uniform and some knowledge of the events leading up to and conditioning the course of that war," as well as to increase the personal interest of the student in his work.

In order to carry out these objectives it was not only necessary to bring about the closest cooperation of various departments on the campus and to organize entirely new courses, but also to reorganize our language material and methods of teaching. In the latter field we developed in each language material of our own, which was entirely based on oral comprehension, discarding old text books and methods of translation. Rather than learning a vocabulary and grammatical rules and constructing sen-

[1] This is the fourth article in this series. Anyone wishing copies of this article or the other articles in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

tences through translation, the students were directly trained in whole phrases through connected conversation material. The students were at first introduced to the new material and then trained in small groups through teachers who either were natives of the respective country or spoke the language like a native. The intensive language training gave each student from two to three hours language drill per day. As supplementary teaching material gramophone records were used. Such records were not only made by the teachers but also by the students themselves, to be used for the correction of pronunciation. The results of this new approach to language teaching were excellent. The students who had never had any Far Eastern language before were, after four or five months, able to carry on a limited conversation in the new language.

We had examples of students who conversed at this stage for half an hour with a Chinese lady in her own languages but had also been given enough between a Chinese painter and a member of the faculty who did not know each other's language. After nine months the students were not only able to understand and speak their respective language but had also been given enough introduction into the reading and writing to enable them to continue on their own. As a proof of this accomplishment, may be mentioned that during the last months several of the area lectures were given in the foreign language. To cover this, field courses on geography, peoples (social institutions), modern history, government and politics, economic structure, and arts and religion were arranged for each respective country. A general course on peoples dealing with race issues preceded the other courses as an introduction. In the area teaching the new emphasis on practical problems of the day in government, especially local government, economics, customs and the like, gave not only the student but also the teacher a new outlook with regard to the material and to the problems of the country in question. The organization of the program in such a short time did not always permit an integration of the various materials at the time when they were taught, but we believe that the subject material discussed covered the whole field of practical present-day problems of the countries and their backgrounds, and that the students received a good understanding of the conditions which they would encounter.

The experience gained in the language training has been since applied to our civilian classes. Our material will soon be brought out in book form.

The program demanded the organization of a large staff, which was provided by the Far Eastern department in cooperation with the geography department, sociology department, political science department, anthropology department and the College of Economics and Business. Additional teachers, especially in language had to be employed. One of the difficulties encountered in the organization of the program was the uncertainty up to the last moment as to what language and areas were to be taught. Until two days before the start, the University did not know whether to teach the students in European or Far Eastern programs, not to speak of the distribution of students in specific language groups. From this uncertainty resulted a discontent on the side of the students who at the outset would, in the large majority, have preferred a European program. However, this feeling was soon overcome and the interest aroused provided a good stimulus for the work.

The majority of our students has been used by the army for work in which they especially applied their training. We hope that the remainder will eventually be used likewise. Aside from this war contribution the program was of greatest importance for the University as it introduced new methods, new courses, and a practical form of cooperation between departments on a regional basis.

AN EXPERIMENT IN EDUCATION: THE ARMY AIR FORCES TECHNICAL TRAINING PROGRAM PREMETEOROLOGY "B" PROGRAM[1]

UNIVERSITY OF WASHINGTON

By C. L. Utterback
Professor of Physics, University of Washington
and
A. F. Carpenter
Professor of Mathematics, University of Washington

In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in your Military Training Program/s for Science Education; for Education in General.*

The Pre-Meteorology "B" training program conducted by the University of Washington under the auspices of the Army Air Forces Technical Training Command began March 15, 1943, and continued for a period of six months. This was a special program designed to supply trained personnel to meet a recognized shortage in a special field. The immediate need for a group of young men of specified mental ability necessitated the training to be directed toward a very definite objective. The subject matter consisted of mathematics, physics, vectorial mechanics, geography, and written and oral communication. This subject matter was specific and suitable for immediate and complete adoption for an emergency program.

The course in Mathematics consisted of the material usually covered in a two-semester course in calculus, certain topics from advanced calculus, the elements of solid analytic geometry, and an introduction to the theory of ordinary differential equations. The students were provided with a day-by-day outline of specific requirements.

The course in Physics included all of the topics ordinarily covered in a year of engineering physics as well as some detailed technological applications of physical principles. The coordination of this course with calculus, differential equations, and vector mechanics permitted detailed descriptions and a more vigorous formulation following the statement of laws and relationships.

The course in Vectorial Mechanics included those topics usually covered in a one year academic course in vectors. Statics, kinetics, and kinematics of particles and bodies were analyzed in terms of scalar and vector quantities. The material on statics was preceded by a study of vector algebra and the dynamical analysis by a study of vector calculus. Emphasis was placed on developing the students' ability to analyze and solve problems in statics and dynamics.

The course in Geography was a survey of world regional geography. The role of geography as a background subject for meteorology was kept constantly in mind.

The course in Communications included drill in writing and speaking. Particular emphasis was placed on the development of intelligibility in the use of communication apparatus and extensive use was made of recording equipment. Subject matter provided by other courses was used almost exclusively in writing and speaking exercises.

Since the course material had been carefully planned well in advance of the beginning of the program, the teaching staff was familiar with its purpose and the proposed attainment of the students. Also this enabled the staff to provide each student with a detailed time schedule of the material to be covered in each course, making possible a main-

[1] This is the fifth article in this series. Anyone wishing copies of this article or the other articles in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

tenance of acceleration in progress. This impressed the students that the importance of their preparation demanded a definite conservation of time for each individual in the program.

The program was set up by the delegation of academic authority to experts in the specified subjects for planning and conducting the course of study. The success of the program was in a large measure due to this delegation of authority by the Army Air Forces, and to the careful selection of students, and to a just but positive method of elimination. This resulted in a homogeneity in classes. These conditions were largely responsible for our ability to take the students, within a relatively short time and with a satisfactory attainment, over a range of subject matter which by conventional standards is ordinarily spread over a much longer time.

A sufficient portion of the students' time, sixty hours per week, was under the control of the academic staff, and the cooperation of the Army Air Forces with the academic staff was of such a high degree that any distraction which might interfere with the students' study was reduced to a negligible amount.

The subjects of mathematics, physics, and vectorial mechanics were coordinated in such a manner that they mutually supported each other. A careful selection in the order of topics in one course supplied subject matter for utilization in the other courses. Vector analysis was presented early in the program. This augmented the work in calculus by giving the students concepts of rates of change such as velocities and accelerations in rectilinear and curvilinear motion. The introduction of time and space derivatives was a definite aid to the student in his understanding of potential functions and the relation between these functions and the forces involved in the dynamical, electrodynamical, and hydrodynamical theorems. The introduction of line, surface, and volume integral theorems served to merge the mathematical and physical aspects of vector processes and was a definite aid to the students' ability to think and work in vectorial language. Many other examples of careful arrangement of topics could be cited in support of the successful synchronizing of physics and mathematics. Such coordination is possible and for this program was found to be desirable as all students were taking the courses simultaneously.

Student reports on their physics laboratory experiments were used as part of the working material in oral and written communication. This collaboration was illustrative of the necessity on the part of the student to clearly communicate scientific information to people who were not especially trained in science.

While most of the students considered mathematics, physics, and vectorial mechanics as the fields of greater concentration, they did profit by the courses in communications and geography. The students' gain in the two last named courses was derived from the fact that the courses were conducted for the immediate benefit of the purpose at hand and not for the sake of preparing them for advanced or specialized study in these fields.

The concentration necessary for the completion of the program at the appointed time raised several questions concerning accelerated study. It is evident that some of the less formal aspects of the subject matter in all of the courses were given minimum attention. The extent of retention of material studied as compared with the achievement attained by excluding the outside interests of a normal college program is debatable.

From the point of view of the rapid preparation of men for a specific part in prosecution of the war our concentrated program with its abundance of hours of supervised study, definitely can be called a success in *training*. The concentration was exceedingly valuable as a means of furnishing students equipped with certain specified abilities. However, our experience points to the conclusion that a similar acceleration would not provide the same degree of success in building a safe foundation for the *education* of university students in general.

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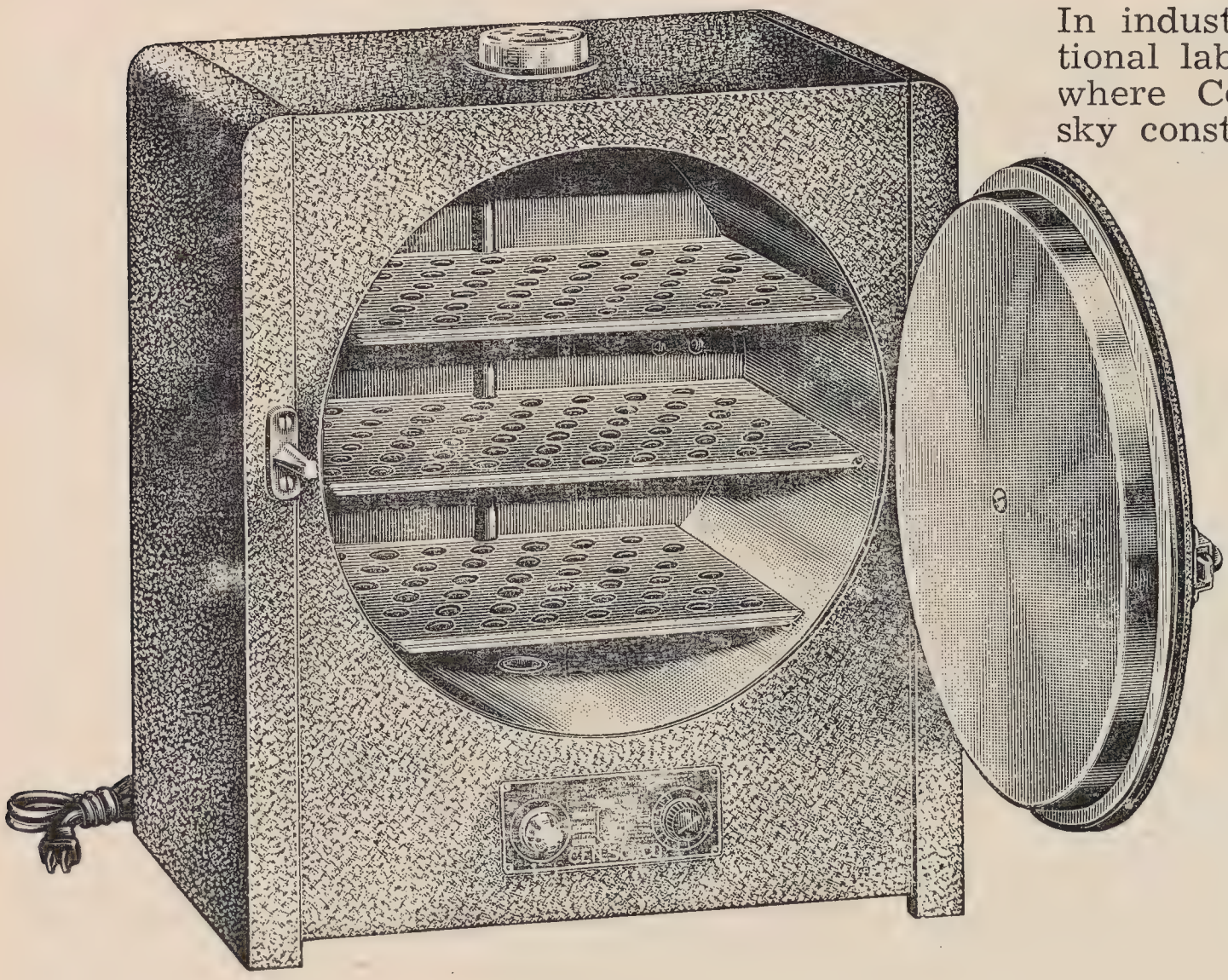

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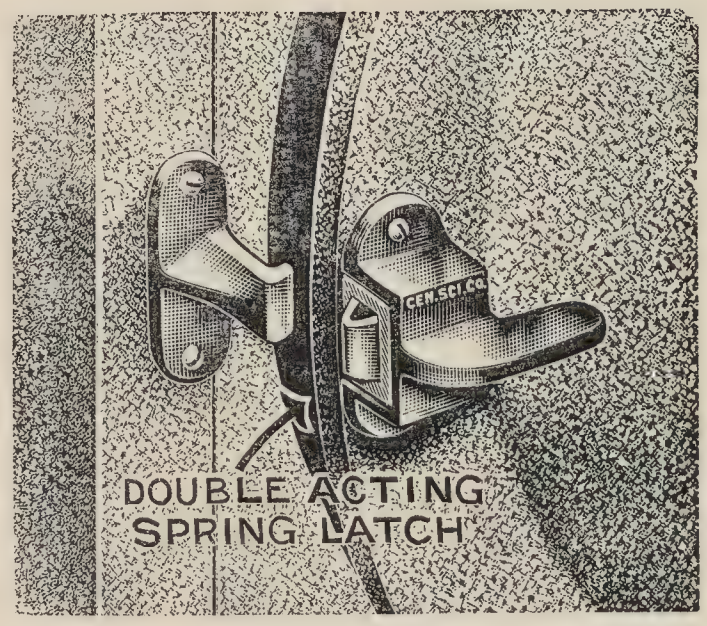

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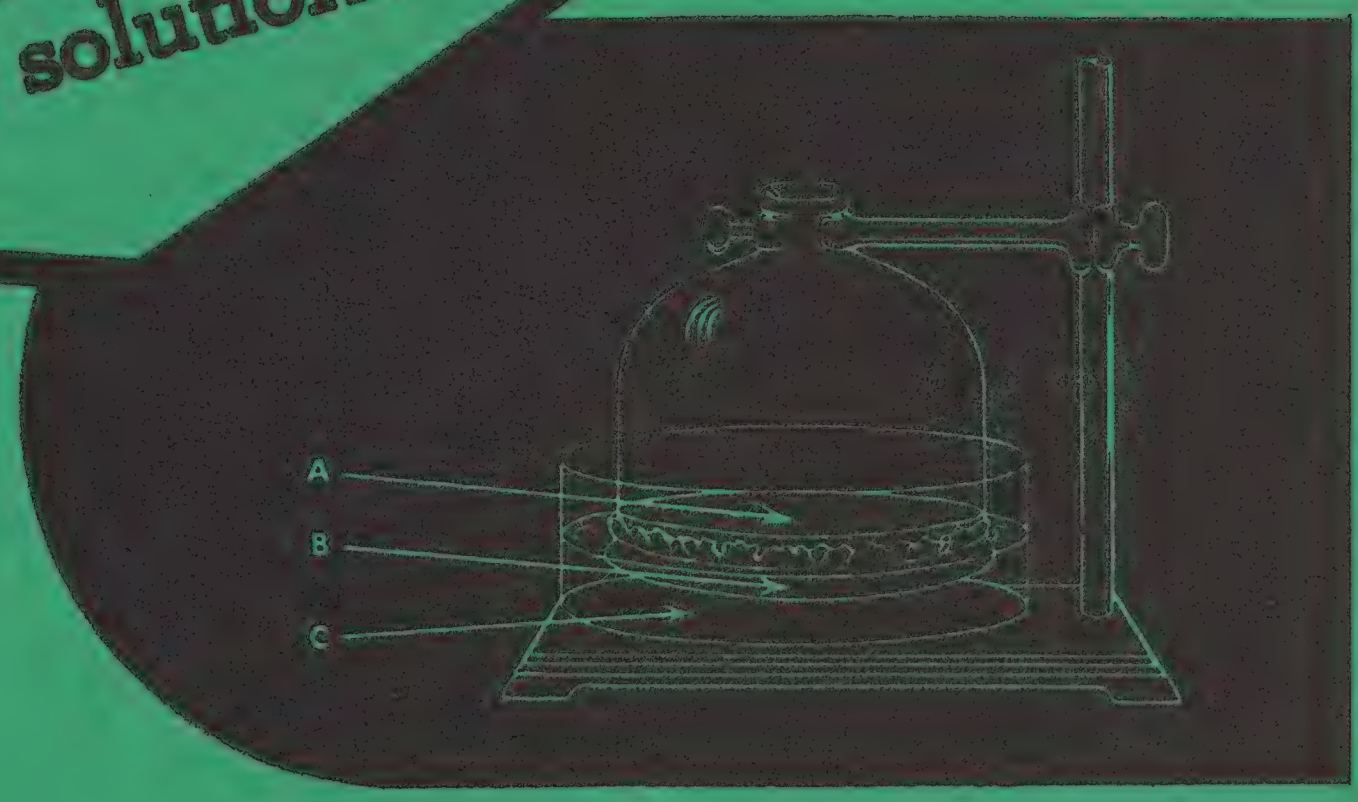

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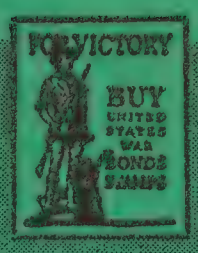

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NORTHWEST SCIENCE

May, 1945

Vol. XIX, No. 2

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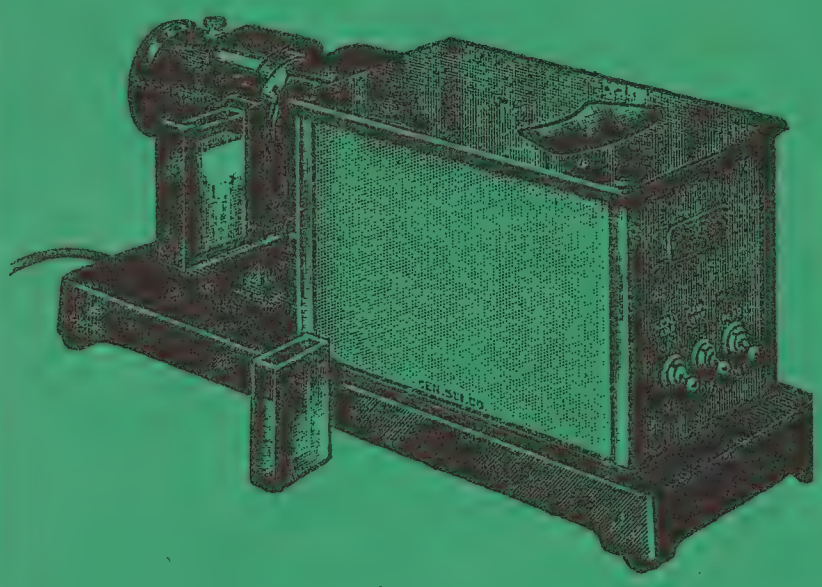

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Volume XIX, Number 2

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL. XIX, NO. 2 MAY, 1945

Editor, W. R. HATCH, State College of Washington

To the Membership of the Northwest Scientific Association:

The post-war period is going to bring with it an opportunity for our returned veterans to get more education. Those of us who will be teaching or directing these veterans must be able to help them find themselves and to direct them into their proper fields of endeavor. Since our membership is representative of many lines of scientific interest, I believe we could pool our information and act as a clearing house for problems of this sort. It is not beyond the realm of possibility that one school might be unable to place a veteran in his proper field. In the case of other veterans, a general education might be more important than specialized training.

I shall be only too pleased to get the reaction of the members to this suggestion, and I am sure the Board of Trustees will be glad to act as a clearing house in this matter.

In these busy days when we are attempting to help in the war effort as well as take care of additional burdens of service or teaching, we are doing many things that we thought we could not or should not do. As a result, it is to be expected that some of us have become aware of problems of a research nature that ordinarily would not have come to our attention. Would it not be a good plan to give thought to some of these problems both old and new and to develop a research program now that we could enter upon when time and manpower are again available?

The Board of Trustees has not been asked for funds for research problems during the war years because it was our understanding that everyone was too busy to enter upon new research. I should like to suggest, however, that now if any of you know of a worthy project that should have our support, you bring it to our attention. A limited amount of money is available for such grants.

R. F. E. Stier, Chairman
Board of Trustees

I have read with interest your introductory paragraph. I feel very definitely that, at the present time, the veterans need most of all a thorough counselling program. If given the proper encouragement and consideration during their re-orientation back into civilian life, I feel sure they will develop into very capable people and some will develop into good scientists. Furthermore, I feel that the Northwest Scientific Association could make a very notable contribution if it would organize groups in locations such as Walla Walla, Spokane, Seattle, Tacoma, and other places where there are government hospitals. I know that the personnel of these institutions are interested and are asking for men who can make themselves available to counsel and direct the men who are coming back into civilian life. It might be that your Association has men that would be available, on call, to go to these hospitals and interview the veterans who are thinking about entering some field of scientific study. I further believe that if members of the Northwest Scientific Association would make themselves available in still other localities, they could help the American Legion and other service organizations to mature still more adequate programs.

One of the greatest needs for our returned men is a friendly understanding, along with accurate information, experienced counselling, and direct assistance in helping them to a proper choice of their future vocations.

U. G. Whiffen, Veterans' Advisor
Washington State College

JUN 9 '45

EFFECTS OF TORRENTIAL RAIN NEAR HEPPNER, OREGON

By RAYMOND T. MICHENER and THOMAS I. WILSON
Soil Conservation Service

How effective is strip cropping in preventing soil erosion? This question, a common one among ranchers, was graphically answered when a torrential storm struck near Frank Anderson's ranch two miles west of Ruggs, Oregon, on July 2, 1941.

The storm started at approximately 3:45 p. m. and poured rain and hail for nearly twenty minutes, covering a 234-acre summer fallow field, adjacent winter wheat areas, a 512-acre watershed in winter wheat and range and a 342-acre field that had been strip cropped since 1937.

Though it was impossible to obtain an accurate measurement of the amount of rain that fell near the center of the storm area, it is estimated that about an inch of rain fell during the twenty-minute period. A rain gauge at Ruggs, which experienced only the edge of the storm, registered .41 inch of rain.

To determine the extent of soil and water losses and the effectiveness of strip cropping under severe rain storms, rill and channel measurements were made in representative portions of the storm area. The following data show that practically all of the eroded material left the ordinary summer fallow field and although considerable erosion occurred on the summer fallow strips of the strip cropping, most of the eroded material was deposited on the grass or grain strips and did not leave the field.

Soil losses of 168.7 tons per acre occurred on a 234-acre summer fallow field which had been disc plowed and rod weeded. Converted to inches of top soil this means that 1.24 inches of top soil were removed from the entire field. The field had an average slope of 12½ percent and no attempt had been made at contour operations.

On adjacent winter wheat areas there was no noticeable soil loss, but it was very evident that considerable water had left the fields. A maximum flow of 115 second feet of water occurred from a 512-acre watershed of which the ma-

(A)

jority was in winter wheat and range. This figure was computed from measurements of the water flow through a three-foot culvert, as shown in picture A.

Directly east and adjacent to the severely affected summer fallow field was a 342-acre field that had been strip cropped since 1937, and which also lay in the center of the storm area. The contour strips were approximately 150 feet wide with 40-foot grass strips established as guides every 300 feet. The cultivated strips were alternately grain and summer fallow. Severe erosion occurred on the summer fallow strips, but the alternate strips of grass and grain were very effective in preventing the soil from leaving the field. The run-off had to pass through a 40-foot grass strip and a 150-foot grain strip before it entered another fallow strip. Cutting of rills stopped as soon as the water entered the grass strip and considerable debris was deposited as the water entered the grain strips. In some instances rocks three and four inches in diameter were carried fifty feet into the grain strips. Practically no soil was lost from the grain strips, but considerable water was lost. Measurements of two summer fallow strips with an average slope of 12 percent gave the following results:

Upper strip—106 tons per acre (practically all deposited on the field itself); equivalent to .803 inch of topsoil.

Lower strip—139.1 tons per acre (practically all deposited on the field itself); equivalent to 1.05 inch of topsoil.

"Conservation pays," said Mr. Anderson. "I'd like to strip crop the field that washed so badly, but at present I just have it leased."

The accompanying pictures show erosion effects in the storm area:

Highway culverts were not made large enough to handle excess run-off from the 512 acres of farmland upslope. A raging torrent below the highway culvert (A) contrasts with a lake above (B).

Mr. Anderson's barnyard is at the mouth of a draw which drains the land damaged by the storm. Outbuildings and fences were washed away by the muddy stream shown in the picture (C).

Tillage marks in the field influenced and sometimes determined the location of small flood channels (D).

(B)

(C)

(D)

AN EXPERIMENT IN EDUCATION:
THE ARMY AIR FORCES COLLEGE TRAINING PROGRAM[1]

CENTRAL WASHINGTON COLLEGE OF EDUCATION

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In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in your Military Training Program/s for Science Education; for Education in General.*

In attempting to answer this question through an evaluation of the program for the Central Washington College, several factors were taken into account. For the sake of uniformity the general procedure followed in formulating the State College of Washington report published in a preceding issue of Northwest Science were used. A second factor affecting the nature of this report was the relatively small size of the instructional staff which minimized the importance of administrative organization and made possible close and informal relations between staff members. The exchange of information growing out of the experiences of individual instructors was thereby facilitated. A third factor was the absence of a number of key individuals who, at the close of the training program, entered other work. Their effective participation was made difficult by the demands and obligations of their new work.

Identical letters were sent to representative staff members who had been associated with the training program asking them to submit papers of 500 to 700 words on the subject "What Were the Lessons in the Army Air Forces Training Program for Science Education; for Education in General?" The persons listed above contributed papers.

An editorial committee made up of Paul E. Blackwood, Bruce A. Robinson, Ernest L. Muzzall, chairman, read all of the papers and noted all important contributions. The next step was to assign topics for the purpose of integrating all material into

[1] This is the sixth article in this series. Anyone wishing copies of this article or the other articles in this series should write to Dr. J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

a reasonably coherent whole. These topics were selected as being best suited to the materials on hand: (1) Administration, (2) Motivation, (3) Acceleration, (4) Integration, (5) Evaluation, (6) Citizenship Training and (7) Postwar Admission Practices. Mr. Blackwood prepared the materials on Integration, Motivation and Citizenship Training. Mr. Robinson prepared those on Evaluation and Acceleration. Mr. Muzzall prepared those on Procedure, Administration and Postwar Admission Practices. The entire committee reviewed the materials as a whole.

One check against errors in reporting the points of view of the contributors was not used. Because of insufficient time it was impossible to submit the completed draft to each member for his criticism and corrections. An attempt was made to offset this omission by checking all moot points to ascertain if the committee members were agreed upon their interpretation. The completed paper represents the combined point of view of the committee as a whole.

ADMINISTRATION

When attempting to assess the values derived from participation in the Army Air Forces College Training Detachment one immediately is made aware that the generalizations customarily accepted about education do not necessarily apply to this program. As a matter of fact, the entire pattern was strange and unfamiliar to the administrative and teaching staff as they embarked on the task of training air corps students in those requirements of mathematics, physics, English, history, geography and medical aid which seemed essential to the students' successful completion of the training program.

Because of the small size of the staff it seemed unnecessary to have division heads. One exception was made in the case of the physical training division. However, there were times when organization by divisions might have facilitated the solution of instructional problems.

In the functioning of the administrative organization all matters of broad institutional policy were channelled through the president's office. Meetings including members of the commanding officer's staff, the academic coordinator and the business manager were called by the president whenever important institutional or Army problems arose. In cases involving the staff and needing complete understanding on the part of all members, special meetings were called and the problems discussed in detail.

Frequent conferences between coordinator and staff members were held. Problems were worked out cooperatively by staff members and coordinator. Conferences with West Coast Flying Training Command inspecting officers were held at intervals from one to six weeks.

Probably the outstanding feature of the program was the spirit of cooperation which existed among the members of the instructional staff, between the staff and the administration, and between the members of the commanding officer's staff and the College. Evidences of cooperative procedures were numerous and are illustrated by the preparation of instructional materials and classroom techniques. Since no satisfactory textbooks were available it was necessary for the instructors to work intensively in developing units of instruction. It was also necessary that techniques be developed in the classroom for speeding up learning and overcoming individual learning difficulties. The entire staff became alert and resourceful in devising better ways of teaching the essentials of mathematics, physics, English, geography, history and medical aid. There could be no acceptance of a textbook as the curriculum. Instructors were eager to assist one another in improving the work of each. Rarely were important decisions affecting the teaching staff made without the matter being placed before the entire staff or the individuals most concerned for their consideration.

Likewise, instructional problems revealed by students to the commanding officer or his assistants were reported

to the coordinator, who, in turn, discussed them with the appropriate instructors. From time to time meetings were held for the purpose of presenting the point of view, purposes and problems of the Army Air Forces concerning the college training program. At these meetings, attended by the commanding officer or his representatives and the academic staff, problems were discussed freely, agreements reached and courses of action planned. This disposition of the Army staff to be of assistance to the faculty and coordinator was extremely helpful. While the "line and staff" principle was followed in organizing the staff, the cooperative practices of instructors, administrators and Army officers gave flexibility and coordination to the entire prorgam.

MOTIVATION

The military aspect of the program emphasized the development in students of a self-discipline becoming an officer and a gentleman. The students hoped to become officers and were challenged by this appeal to do well in their work. The fundamental motivation in the program, however, was inherent in the ultimate purpose of the program which, broadly stated, was to help prepare men to serve effectively as flyers in the Army Air Forces. Since this broad purpose was served by minor objectives in each subject, we can look to them, too, for evidence of their motivating influence.

The purposes of the academic program appeared to be (1) to help the men to adapt to the routine life of a student—that is, to learn how to study; (2) to help them become generally well-informed; (3) to help them gain a proficiency in subject matter and skills directly applicable by them in flying. These general purposes were implemented in varying degrees by different subjects.

The objectives and values of the physical training program were explained to each new class in an orientation lecture. It was felt that this orientation aided considerably in securing the cooperation of the men. The students liked most of the program and worked to improve their ratings, particularly since they saw the relationship between having good health and the ability to be good flyers.

Students became more interested in a phase of physics when they saw its application to combat flying. The law of falling bodies did not particularly interest them until it was applied to a falling bomb. The study of laws for the combination of forces was rather dull for them in the abstract, but was regarded quite differently when expressed in terms of the forces acting on a plane. In mathematics, likewise, when problems had direct application and recognized relevance to flying the students at once became more interested.

In medical aid the primary purpose was to give, in a short time, enough practical working knowledge of medical aid to take care of single or mass accidents. The instructor in this course emphasized the types of accidents which the aviation students might experience, the appropriate medical aid for each type and carefully checked each student's knowledge on the most common and important phases of medical aid before the student graduated. Students worked to obtain the minimum essentials and as much more as possible because they recognized the practical value of a knowledge of medical aid.

At the outset of their training many students did not accept the objectives of the program as being valid. They questioned whether a student would become a better flyer for having studied geography, history and English. Such objections usually indicated a lack of understanding of the several purposes of the program and usually were withdrawn when the purposes of the program were fully understood. This point suggests that sheer awareness that they were training to become flyers was not always sufficient to encourage the best efforts of the students. It remained for them to be convinced that the program was valuable toward that end before the program became properly motivating.

However, an examination of the program reveals several other motivating factors which operated somewhat inde-

pendently of, though related to, an understanding and acceptance by the student of the ultimate objectives of the program.

Interest in academic work was important. In physics and in medical aid manipulative skills were usually of greater interest than discussion alone. Laboratory work in physics and practice with splints and bandages in medical aid were undertaken with considerable enthusiasm. Sometimes special interest in a topic developed for the class when a student revealed himself to be a person of experience with reference to the topic. Student experience covered a wide variety of previous vocations. In the physics classes contributions by these individuals with special vocational experience gave a solidity to the discussions. Frequent flaws in thinking and real misunderstanding of physical principles were sometimes apparent in the statements of students who professed an expertness on a particular topic. This necessitated further study of the physical principles involved. Hence a good learning situation was present and the instructor who did not take full advantage of it missed an opportunity.

Interest in geography had to be developed because of two factors: (1) a natural tendency for men to believe mathematics and physics would contribute most to their practical training caused them to concentrate their efforts in those fields at the expense of geography, history and English; (2) immaturity of students in their knowledge of geography. In regard to the first point, it was necessary to remind students frequently of the practical implication of the geographical material. Actually this was not difficult. Much of the material was obviously practical and was accepted per se by the students. Maintenance of interest in materials not directly pertinent to aviation was not too difficult because much of it dealt with war theaters and other geographical phases of the war.

Just how effective Army classroom discipline was in maintaining interest—except a type of forced interest—is a question. It had the advantage of securing an orderly and apparently attentive class, but did mitigate against the occasional spontaneous class discussion that profitably enlivens an otherwise routine period.

In the physical training program, particularly, students competed with themselves and with each other in an attempt to better their records. Some competition was observable in academic classes but it was not so pronounced as in the physical training program.

The desire for group approval and the tendency to work for good grades were strong motivating factors in the academic classes. The psychological need for a healthy kind of group approval is recognized. In the program here, evidence of constructive group work often led to desired positions of leadership and frequent special privileges. This factor seemed to be of a positive nature and should certainly be given ample consideration in any well-planned educational program. Most of the evidence indicated that g r a d e requirements served merely as artificial motivating devices, that getting passing grades was a means of preventing some punishment or loss of privileges. A more positive kind of motivation should be striven for.

What is believed to be good teaching in one situation may not be good teaching in another, and when final evaluation of good teaching is made it must be in terms of the objectives of the teaching program. A number of fairly specific recommendations can be suggested that will apply toward improving education in general, though probably no techniques of great importance that were not already recognized came out of teaching the Army course. The chief lessons resulted probably because instructors were made sensitive to certain philosophies and techniques which they could carry over into some other teaching program.

In geography some of the suggestions are:

1. In the past geography instructors have often placed little or no emphasis on formal place geography. Names and places were learned as needed. In the

Army program involving aviation students, it seemed advisable to drill on the place names of war theaters. These exercises have been used to advantage in college beginning geography classes. In addition to learning place names, the college students become familiar with wall maps and atlases and the areas they symbolize.

2. The several kinds of college Army programs brought forth a number of new books and materials on map projects, meteorology, and cloud types. The new materials on cloud types, e.g., make possible lesson units on such material. Students entering teaching can now teach such units in their science or geography periods. In addition to learning clouds as weather signals, the study of clouds, involving both science and art, might be developed among pupils as a hobby, such as many have with ornithology, rock collections, star study, etc.

3. Because of the shortness of time certain systematic materials were taught best to aviation students by means of mimeographed lessons. No single text seemed to cover the topic of map projection, for example, properly. Mimeographed material made it possible to bring such data adequately and simply to the students.

4. Mimeographed exercises, dealing with map scale conversions, contour lines, grid coordinates, and great circle routes were prepared for the aviation students and worked by them somewhat in the spirit of playing games. These exercises were frequently worked in class, thus also serving as a device to vary class procedure.

5. Teaching was inspired by the fact that the better and faster the men learned the materials offered, the more the instructor was contributing to the success and the conclusion of the war. A similar spirit should be carried over into teacher-training or college education in general. A feeling that the materials taught are effective in turning out mature citizens with better techniques and materials with which to "fight ignorance" should be developed.

Worthwhile emphases suggested by the experience of teaching physics to the aviation students include the values of laboratory work in gaining an understanding of physical laws, the value of manipulating instruments in developing understanding of physical laws, and, in medical aid, as was pointed out, the actual practice of administering first aid treatment was the practical step which made the individual competent in a real emergency.

It would seem, then, in considering the problem of motivation for education in general that the greatest hope lies in engaging students in educational pursuits and activities that will help them attain a desired and foreseeable end, culturally or vocationally. And inevitably the fact must be faced that the society in which young people are growing up must be so organized that the desired vocational and cultural goals will be available. Such a society would, indeed, be the greatest possible motivation for young people to desire an education.

ACCELERATION

The Army set as an objective of its college program the training of men who would be capable of executing successfully their assignments in a world at war and simultaneously, the educating of these same men to be enlightened citizens of the peacetime democracy of tomorrow.

Due to the length of the outline the instructor had to select materials in the light of attaining this objective. Certain phases of broad scope had to be streamlined. Other materials were omitted, but that which was included was learned quickly and well. There was little time for repetition, and students whose background or study habits were poor found it almost impossible to maintain the accelerated pace. In general, however, the men were able to attain to the Army standard even at the increased tempo. This acceleration definitely showed the instructor that there is a saturation point for the rate of presentation of new ideas and that time for "intellectual digestion" is a factor in learning. This program realized unusual success in training but not necessarily in education.

It is not suggested that peacetime education should adopt such a "speed-up." First, it was found that due to lack of time, certain important parts of each subject had to be omitted. Civilian education would suffer as a result of such curtailment. Secondly, the men in this program were subjected to motivations much stronger than those ordinarily found in peacetime education. This undoubtedly contributed much toward the success of the Army program even at the increased tempo.

Possibly the Army's success at the accelerated pace suggests that certain fundamentals might be learned in a shorter time than has been traditionally allotted to them. To accomplish this, educators might choose areas of such importance that the inherent motivations will supply the necessary power for the desired increase in the rate of learning.

INTEGRATION

The term integration is being used to describe two situations which to some extent enter into all educational planning. First, the problem of coordinating the efforts of instruction in all academic fields toward implementing the objectives of the whole program. Second, the problem of presenting in a uniform or consistent manner topics that are taught for emphasis in more than one course.

It was hoped by the Army command that the subject matter initially incorporated in each course was so selected that the objectives of the total program would be adequately implemented. The instructors in the various subjects did considerable *departmental* planning in order to clarify their own objectives and left to the Army command the problem of assuring, through its curriculum directives, that all necessary subject matter topics were covered. Frequent changes in the directives demanded frequent changes of emphasis in topics taught.

After a few months a stability was reached which permitted departments to look around to see wherein greater effectiveness could be achieved by more *inter-departmental* planning. It was at this stage that geography, mathematics and physics departments, for example, found it most easy to plan—that is, to exchange ideas about their respective functions in the program.

There was genuine willingness on the part of instructors to make desirable changes in their courses as a result of inter-departmental planning. But it was relatively difficult to change because of the very fact that certain topics had been presented for a few months in a given subject. It is important to point out this difficulty because it gives an opportunity to observe that greater *inter-departmental* planning before the inauguration of the program would have led more quickly to a sound, over-all program—a program without unfortunate gaps in content or without undue overlappings.

The confusion in the development of the academic program was to be expected. It was fortunate, then, that a program was not adopted without administrative provisions whereby it could metamorphose and grow. Its very experimental nature demanded frequent evaluation and changes to improve its defects. Changes did occur to meet recognized needs. The same should be true of any progressive educational program.

Integration of the second type was more a planning of details. If, for example, the mathematics descriptive of falling bodies were taught in mathematics and also in physics, could not the same symbols be used in formulas used in both courses? Could not the same symbols be used in formulas for time, rate and distance problems, for thermodynamics and all other formulas studied both in mathematics and physics? This was not fully achieved but the desirability of uniformity was recognized and achieved to some extent. In mathematics and physics the procedure in use and construction of vectors, especially as used in wind triangle problems, was presented uniformly. In medical aid the instruction was planned according to the best practice recommended by the chief medical aid agencies—the American Red Cross, the U. S. Bureau of Mines, the British Red Cross, the U. S. Medical Corps. These examples show

types of integration and suggest our recommendation that such types of coordination are of value.

EVALUATION

The academic testing program was composed of three types of tests, the entrance examination, the class test and an achievement test. Each of these will be considered in this section. Each candidate for the Air Force college program was given the AC20A or AC20B test prior to his assignment to the college training detachment. This was an objective test which attempted to measure general knowledge in the fields of English, history, geography, mathematics and physics. Each individual's scores were made available to the College. Army regulations did not allow the instructors to examine the test but considerable agreement was noted between the test scores of students and their progress in the program. In most classes the top ranking men usually had high entrance test scores and men with the poorest academic records ranked lowest in the test. It seemed that the test scores gave an indication of probable success in the program.

Each individual's scores in this AC20A or AC20B test were recorded and used as a basis for sectioning. The men accepted the sectioning without protest and often indicated they appreciated the attempt to place them at the proper learning level. These test scores were used by the instructors to better understand and remedy student weaknesses. The use of this test indicated that a valid test given to all students entering any phase of school work might result in better student adjustment.

Weekly grades were required, so each department used a set of tests prepared by all the instructors of that department. Careful records were kept of class scores on each test. This data proved valuable as a scale for grading successive classes. Error frequency charts were compiled for all tests. These enabled the instructors to eliminate faulty questions and recognize areas that needed additional emphasis. The men who failed in the weekly examination were assigned to a daily evening study hall with the proper instructor in charge. The instructors felt these remedial classes were worthwhile since they provided the opportunity to become better acquainted with the needs and weaknesses of individual students.

Each graduating class upon reaching Santa Ana was given a companion test to the AC20A or AC20B entrance examination. Again the test questions were withheld but the class record in each subject was reported. In addition each school was rated with the remaining schools in the Western Flying Command. These ratings were a continual challenge to the instructors and stimulated improvements in teaching. It was unfortunate that the instructors had to "shoot in the dark" so to speak, since they had no definite knowledge of the material covered in the test.

In the physical education program each man was given the P. F. R. (Physical Fitness Rating) test. This test measures physical fitness and is so simple to administer, it can be easily adapted to any school physical education program.

It was felt that the academic testing program was well planned and gave instructors ample means for a check on student progress and teaching success.

CITIZENSHIP TRAINING

It is the purpose in this section to examine the Army training program for examples of constructive policies, practices and procedures that can, in our opinion, be recommended for education for citizenship. Recommendations drawn from experiences in a program focused toward successful execution of a total war may have their limitations in a broad program of education for times of peace. Even so, there are certain suggestions which may be valid, particularly since a thoroughly acceptable citizenship education should prepare citizens to cope intelligently with *whatever* social problems exist—in a world at war or at peace. The presence of war, of course, marks a failure up to that time in coping adequately with certain major social problems.

In a democracy, competence of several types may ideally be expected of its citizens, and many of these competen-

cies should (or must necessarily) be developed in the school.

The characteristics of good citizenship used in the following headings are certainly not mutually exclusive nor completely descriptive of good citizenship. But with reference to them we can examine the Army program for its contributions.

Living Democratically in Small Social Groups

Cooperation is characterized in democratic living by its presence in furthering projects which have resulted from decisions mutually acceptable to the group. The tendency to cooperate is usually present in conditions where mutual understanding and respect exist. This was apparent in class room situations with respect to teachers and also flight leaders. If the leader was not well chosen, if he managed his men ineffectively, the men resented it and only because of compulsion cooperated. Good leadership improved the morale of flights and tended to nurture cooperation.

Democratic living implies a degree of liberty and freedom of choice and action. In an organized society this liberty carries with it certain responsibilities. This is a widely accepted truism, yet not under all conditions will individuals reflect in their behavior what they accept in principle. Our observations in this program support this point. Under Army discipline aviation students had relatively little time in which they were free to choose and plan their activities. During routinized activities such "liberties" as students had were permitted within narrow limits—usually liberties of means of execution, not of ends. When students were not under supervised control the liberties and freedoms which they exhibited were frequently characterized by irresponsibility. Types of behavior were exhibited which would not be sanctioned under the military discipline. The point here is not to criticize the aviation students but to suggest that there can be no assurance that superimposed rules of behavior, acceptable in one situation, will be followed in a different situation when the controls are no longer present. And, further, it seems evident that in training individuals to accept responsibility along with their liberties there must be frequent opportunities for making choices in many types of activities, especially in types of situations where the consequences of irresponsibility might be socially detrimental.

An Honor Council of the aviation students dealt with infractions of discipline by individual students. But more important it made recommendations for improving the group living in many respects, often solving problems which would not have been solved by an arbitrary decision from superior officers. Experience in this group effort gave effective training in this democratic technique.

Intelligent Extension of Democratic Procedures in the Local, State, National and World Communities

The very fact that thousands of boys from different parts of the country were brought together meant that there would be a widespread exchange of ideas representing different parts of the country with their varying political, economic and cultural concepts. Tolerance toward divergent points of view must be based on understanding of those points of view. The fact that boys were brought together may represent a small beginning toward developing inter-regional and inter-state understanding. The specific study of geography, history and international affairs should further this trend.

If scattering men and women throughout the world succeeds, by some human alchemy, in increasing international tolerance and understanding, then there should be a large residue of such understanding when the war is over. A logical extension of this idea suggests that in planning educational programs for the future we should encourage on a widespread basis the exchange from state to state, from nation to nation, of large numbers of students and teachers. Widespread travel should be encouraged.

Knowledge of Public Problems and Competence in Political Action

The Army program contributed only incidentally to developing these aspects of good citizenship. The above criteria imply such things as knowledge of civic organizations, community, state and national problems, techniques of political action, methods of persuasion, party organization, voting procedures, responsibilities, etc. The general education gained in the program, in so far as it made the students well-informed individuals, should help in the development of these competencies. The program may have made the students conscious of the need for more competence in these areas.

An Intelligent Loyalty to the Principles and Ideals of American Democracy

One of the specific objectives of the history course was to develop this phase of good citizenship. The hope was that an intelligent understanding of the historical origins of the American people, a knowledge of their aspirations, the origins and roots of the present conflict, would develop such a loyalty in the students to the extent that they would be convinced of the necessity of fighting to regain or maintain those ideals. It was generally agreed that the teaching should not encourage loyalty to the failures of the past, to the pseudo-American traditions often over-emphasized by strong minority groups, nor to forces and tendencies falsely labelled Americanism now and in the past. Rather, that the whole picture be understood and that a strong loyalty be built on the American ideal in its very best sense. This is the cue for good citizenship training in all our educational programs.

POSTWAR ADMISSION PRACTICES

An examination of the records of the many classes of the 314th College Training Detachment reveals that the educational background of the students ranged from the completion of the seventh grade to six years and more of college or university education.

In general, those students with college training in technical and scientific subjects made the best academic records in this detachment. There were numerous exceptions, however, and some superior academic records were made by students with less than four years of high school education.

The following conclusions seem valid. First, there are various ways of securing the equivalent of a high school education. Hence some individuals through their out-of-school experiences have acquired a maturity and competence which qualify them for admission to college. Second, college admission practices should be modified to admit such students. Comprehensive examinations similar to the Tests of General Educational Development published by Armed Forces Institute should be used to determine the college status of these students.

The comprehensive records of experience compiled by the Institute for servicemen provide another source of information concerning the probable college status of those mature students lacking high school graduation. Third, if these facts are generally found to be true, the student entering college should not be expected to repeat in college those courses or major segments of courses which he has previously mastered. To require him to do so would seem to be a waste of time and energy.

In short, mature students entering college and possessing special competence in certain fields should be treated as such. Evaluation of these competencies through formal examination, conferences and authentic records of previous experience should be made by the institutions of higher learning to determine the educational level at which the student should begin his work and those required courses he should be required to take. Such a policy should result in conditions which would challenge the best efforts of students and minimize the tendency to "mark time" so evident in the past of many college students.

AN EXPERIMENT IN EDUCATION:

THE ARMY AIR FORCES COLLEGE TRAINING PROGRAM

MONTANA STATE UNIVERSITY[1]

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In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in Your Military Training Program/s for Science Education; for Education in General.*

Papers prepared by the above named contributors were turned in to the coordinator. He has taken the responsibility of clipping from these papers and reorganizing the article in its present form. Time has not been sufficient to allow the actual contributors to reread the completed article. The coordinator must, therefore, take the responsibility for such misrepresentation as may arise from moving paragraphs out of their original context. Such parts of the article as are not introduced by the initials of a contributor should be credited to the coordinator.

Although the entire article is pointed toward the idea of realizing benefits in the future, the more general remarks in this field have been placed in a particular subdivision headed, "Lessons for the Future." Under the heading, "Aids from Santa Ana," we have attempted to place the references to outlines which came from the Santa Ana base as well as the suggestions from there which seem to have impressed the contributors particularly.

INTRODUCTION

The Army Air Force College Training Detachment came to Montana State University with a number of trainees equal to about one-half of the normal prewar registration of the entire University. The faculty was finally made up of regular faculty members teaching in their own departments, regular faculty members "converted" to other departments, and persons especially appointed for the duration of the program. The success of the training course was due to the fine cooperation of this somewhat heterogeneous group of faculty and the very good relations which held throughout the period with the representatives of the Army.

ADMINISTRATION

The administrative set-up was, to a large extent, separate from the corresponding set-up for the regular work of the institution. The coordinator maintained very close relations with the supervisors in the various departments,

[1] This is the seventh article in this series. Anyone wishing copies of this article or the other articles in this series should write to Dr. J. W. Hungare, Eastern Washington College of Education, Cheney, Washington.

and with many of the individual instructors. Army directives were accordingly discussed very generally before they were put into effect.

(GDS) Physics: To aid the newly recruited physics teachers, we worked out a syllabus which listed the subject matter to be treated and the methods of treatment. This syllabus was accompanied by a weekly schedule of topics for each hour. It was further supplemented by special instruction given the instructors on the handling of equipment for demonstration and methods of presentation of topics.

One reading the above will immediately say that we were administering a program that might be characterized by such phrases as "highly centralized," "lock step," etc. We saw this in advance, regretted it, but did not see any other way of carrying on the program. Because it was so highly centralized, we met many difficulties.

(WES) Physical Education: Administration was much simpler than during the regular college year; army discipline again being the main factor responsible here. We no longer asked the question, "What would you like to do?" but with a set curriculum handed us, it was, "You do this."

FACULTY MORALE

Faculty morale was good throughout the program. In spite of the necessity of doing many things in a new way, and some things in a way that seemed wrong, the faculty members were willing. Naturally, their morale was shaken by the wholesale separation of trainees from the Air Forces a few months before the termination of the program. Even so, they labored hard and fairly successfully in keeping the trainees in hand during that period.

(WPC) History: I already had a high regard for young men of this country. Contact with these men gave me even greater faith in them. Such men will do what they are set to do, even learning History under trying conditions, in which it is made, or allowed to appear, of minor importance.

(GDS) Physics: While we were anxious to take on any kind of work which would help in winning the war, we realized certain shortcomings that would have to be overcome if we were to carry on the instruction required for the program in a successful manner. The principal shortcomings were the lack of an adequate teaching force, the lack of equipment, and the lack of classroom and laboratory facilities for handling the large number of students that would be allotted to us. We realized that the kind of instruction in physics desired by the army authorities for this program was considerably different from that which we were accustomed to practice; whereas, traditionally, we were habituated to the belief that principles were the important thing in a physics course, it appeared that in the proposed program we should have to shift our emphasis to the factual and to accentuate the factual subject matter of physics that would be practically applicable by narrowly trained aviation students.

One might suppose that instructors, recruited as ours were, would show up many differences which would be hard to harmonize in such a highly centralized program. To some extent, that is true but I am almost astounded at the few differences of this type that did arise. Our instructors realized the difficulties we were up against, and, on the whole, tried to cooperate and collaborate even at times when this meant personal sacrifice, as for example, an excessive teaching load, an unfavorable schedule, or teaching subject matter with which the instructors had had little previous acquaintance.

(JWS) Geography: At first faculty morale was poor because most of us were transferring skills and working in a field in which a considerable amount of preparation was necessary. Furthermore, at the beginning there was not a clear cut outline of what might be expected and we were often working in the dark. Even after we got a topical outline there was difficulty because for a time an attempt was made to hold all sections to the same pace. As soon as directions were given which allowed each section to follow its own

pace—as nearly as could be judged—there was material improvement.

(WES) Physical Education: The effect on the teaching staff was also marked. My staff were on their toes putting life and energy into the work. Students under army discipline were compelled to report promptly and there was never any straggling into a class after it had started. There seemed to be a much closer relationship between teacher and student—a greater interest in the individual student.

With a definite standard of check I found that my staff were interested and desirous of bringing their individual phase of the work up to or above the standard set by Santa Ana.

This, of course, involves the old principle of competition and I know of no better way of stimulating both teacher and student.

(CFH) Physical Education: Faculty enthusiasm for the work was excellent and proof of this fact lies in the statement made by a group of the trainees to the effect that they liked our program and the instructors because these instructors did themselves whatever they ordered the men to do. It was a constant challenge to the instructors to show that they could keep ahead of the trainees in all around performance. This was not a very simple task with two thousand grown men to compete with.

MOTIVATION

In general it can be said that for young men between 18 and 26 years of age, the fact that they will receive flight training in four months if they can carry a prescribed academic load in the meantime, is a very powerful motivating factor. However, motivation becomes more complicated. Even with a fairly immediate objective, minor discouragements sometimes assume the role of major importance. The reactions of those doing the instruction under these circumstances tell some of the story.

(JWS) Geography: While many of us may not like some aspects of regimentation, it should be pointed out that there are certain advantages when a group does some things as a disciplined unit. The slight military discipline involved in marching, filing into the class room, coming to attention for a moment before the instructor, and the maintenance of a somewhat military posture during the class hour, seemed to react favorably upon the men themselves. Whether they liked it I do not know, but at least they gave all indications of being more alert than they otherwise would have been.

(HGM) English: The sense of discipline felt by the cadets cut down student inclination and willingness to say, in class, "I don't know," and encouraged the making of an effort. There developed, often, a group spirit that made the individual student less willing to fail himself or his group by not making an attempt. The discipline also helped create an atmosphere of formality (not lacking, however, if the instructor could help it, in geniality) which, in turn, gave a sense of seriousness and of importance.

(JM) English: From the point of view of a teacher of English the program presented a number of problems both different and valuable. First, the men had clear objectives; they knew where they were going, what they wanted to do, what in general they were being trained to do. That fact, astounding in many ways after the academic generalities, the academic situation of students vague in intention, set to the pattern of a four-year growing time, it seems to me, stands back of the values to be learned from the Army program. We were left to focus clearly and constantly on the virtues of direct and exact and practically meaningful communication, written and oral.

I must, however, in all fairness say that these objectives, apparently so clear-cut, were often most difficult to convey to the students. The virtue of knowing where you are going can also be a vice; the road they followed was to them often so direct in their minds that they failed to see what possible relationship English could have with it. The problem of "selling the course" carried over, then, into Army teaching; in the academic field we have long grown

used to it. Happily enough, the parallel continued even farther; all but a few (always there are a few) came to realize the validity of the work in English.

(GDS) Physics: One would suppose that students in this program would be highly motivated. Unfortunately, that was not the case, but such motivation as they did feel was decidedly helpful with, perhaps, more than half the students. One difficulty upon which all of us agreed was that the student was called upon to do too much individual study. This proved a severe handicap.

(EK) Mathematics: We must somehow find means of motivating students in civilian education to the same degree they are motivated in the army programs. The CTD students were highly motivated by the incentives of promotion and advancement. They worked hard and long at their lessons. This suggests that in the future we should ourselves strive harder to develop worthwhile incentives in civilian mathematics teaching. There is of course no magic key to motivation. It is likely though that we shall get better response from civilian students to the extent that we relate the study of mathematics to life problems—especially to vocational interests and ambitions, to the mathematical needs of everyday living, and to construction and engineering projects in our communities. This is not easy to do in a field in which a substantial foundation in elementary skills must be laid before applications become too evident, but the attempt is well worth making.

(CFH) Physical Education: Student leadership was encouraged and was carried on under the guidance of a staff member. Since the Air Force program was one of training potential officers, the development of leadership at this basic phase of the career was considered a good stepping stone to success.

Tests of physical fitness were given at the start and finish of the period for each group. Records were kept and posted of the test results in all skills.

Interest and morale of the men was high and programs of competition were arranged for evening hours and weekends.

SECTIONING

(EK) Mathematics: Students were divided into ability groups on the basis of an initial placement test in mathematics. This process yielded groups which if not "homogeneous" at least had similar needs and problems in relation to mathematical subject matter. Fast groups were able to progress rapidly and to include topics not listed in the course of study itself. Teachers of slow groups were able to adjust the pace to the ability of the class. They could take time to explain and re-explain simple processes, which certainly would have been a waste of time for the more advanced student.

(JWS) Geography: I am still not clear as to the end result of sectioning according to ability. What advantage there may be in having a group of students more or less alike in intellectual capacity is perhaps offset by the fact that a group rated low in ability is weighted down by its own load; that is, without two or three fairly keen students there is very little spark left in the class. Certainly the teacher who had one of these low rated sections usually worked in an atmosphere of personal depression. Along toward the end of the program some of us gave short quizzes (10 to 12 minutes) two or three times a week rather than one longer weekly quiz. On the whole we seemed to get much better results with the short and more frequent quiz. This seems to bear out the generalization that few students are so greedy for knowledge that they do not need continual "prodding," at least in the earlier years of their educational work.

(CFH) Physical Education: To facilitate instruction, men were grouped where necessary according to ability. Instruction in all activities was outlined and taught progressively by the instructors of the University staff. Groups rotated and were exposed to instruction in all of the activities.

SPEED UP

It was undoubtedly due in part to the process of sectioning that the non-science departments were more impressed by the effect of acceleration. It

should be remarked, however, that the acceleration seemed less harmful at this institution as practiced in the Air Force program than as applied in the Army Specialized program. The longer the period of acceleration, the more unfortunate it seems to become.

(HGM) English: Instruction in English in the Army Air Forces CTD program at Montana State University followed a pattern based on the specific uses to which, as nearly as could be judged, speech and writing would be put by the men who finally attained membership in the Air Corps. The definiteness of this pattern made possible economical instruction, a condition that does not always exist in instruction in speech and writing. It also placed upon instructors a need for precision.

This pattern did not include literary uses of language; neither did it embrace commercial uses. It cleared away a variety of aims and materials which ordinarily are assigned in colleges to the work in required composition. This simplification worked for use of explicit and even incisive methods of instruction to reach the clear objectives which remained. Students, as a result, recognized a distinct march toward goals, day by day. The class work gained continuity and a building of elements one upon the other.

The pattern had woven through it emphasis on observation, definition, and analysis. So constant was the drill in these tools of thought and so basic did they come to be for thinking and expression that students should have emerged from the training with recognition of the importance of these processes.

These same features of clear-cut pattern, of narrowness of objectives, of scarcity of time, and of discipline carried within themselves, as well as the advantages that have been indicated, certain disadvantages. In general, however, some colleges and universities could profit from adherence to them, especially from economy of time and from the striving for precision in instruction and in learning.

(JM) English: In the teaching of the fundamentals of grammar, the basic factual material that becomes the foundation for composition work, I feel that much may be learned from the Army experience. Through pressure of time we achieved a new precision, often perhaps too dogmatic to be entirely good teaching in the academic situation, but at least productive of results over a relatively shorter time than those we achieve now. Perhaps here lies a possible way in which we can profit. Information that comes to us from time to time concerning educational practices in Army schools (service schools in distinction to Army programs in colleges) indicates the possibilities of using visual aids on a much larger scale to present materials essentially factual to larger groups Through carefully prepared lessons and a careful eye on the time we came to approach a little of the implied economy of such a procedure. But the other side of this situation presents the problem of paper-reading and the obvious values of conferences and individual aid, both of which values become complicated with larger groups of students.

To achieve these ends is not easy, nor is it a quick process. I do not believe that we achieved our complete aims in the Army work, limited as those aims were, partially because the learning process in such a subject is relatively long. That is not the whole reason, of course. But the point here is that shortening of course duration in English composition is not one of the lessons that the Army program should have taught us.

(JWS) Geography: Here and there I have seen statements to the effect that the army program taught universities and colleges that they could speed up education. Nothing in my experience in teaching army geography seems to justify this statement. Even in the so-called better sections I would say that the students could handle no more items of learning than can our regular academic students, and perhaps not quite so many per time unit.

I saw nothing to indicate that it was

possible to "learn more in less time" and I have wondered how much exposure to short courses might influence the attitude of the individual student toward a possible future educational program. It seems to me that there were indications that some of the men thought that they knew all of geography, all of physics, and so on, and that they were left with the impression that universities could teach the contents of almost any subject in less time if they cared to. Anyone participating in the teaching of any of the subjects of course realizes what a small part of the basic content was actually given in any of them. This does not mean that the program failed to do what the army set it up to do, namely to give enough of several contents to make the students not only better trained airmen, but also better qualified to serve as officers of the U. S. Army. But educating for a particular skill or activity is *training* rather than *education* as used in the broader sense. I see nothing to indicate that one third of a content can equal the whole, although in a "speed up" program it may be better than no content at all. The "time factor" seems important in the educational process. Undoubtedly a few selected students might meet the pace of an accelerated program. I believe that the average student needs more time—rather than less—for ideas to "soak in." He may "loaf" part of the time, but that leisure seems essential for assimilation.

AIDS FROM SANTA ANA

Directives from Santa Ana were not in all cases looked upon as aids. Changes were ordered when practically unanimous opinion was to the effect that the current plan should be allowed to have a chance for success.

(WPC) History: We were asked to teach by the question and answer or discussion method, though instructions were not always clear and specific on this point. The classes were too large, running from 35 to 50, for effective group discussion teaching. Such a method allows of only about 15 as a maximum. The tendency was for certain active members of the group to do all or most of the talking.

(JWS) Geography: The suggested outline as to order and content of materials sent from Santa Ana, although late, was helpful, and, considering the probable needs of the men, well done. Some of the suggested teaching methods seemed impractical and more or less impossible to follow out. The suggested discussion type presentation was oftentimes not very effectual because the students had not done enough personal preparation to offer much in a discussion. Similarly, the suggestion that topics should be developed on a 3-minute basis did not work out so well, because oftentimes continuity seemed more important than breaks in order to develop a given topic.

(CFH) Physical Education: The program of physical education as provided for the Army Air Force students at Montana State University had the following objectives:

(a) The development of an optimum state of physical fitness.

(b) The development of an appreciation of the benefits of this optimum state of physical fitness in relation to one's functional ability.

(c) The development of fundamental skills.

(d) The development of leadership.

(e) The development of alertness, courage and aggressiveness.

These objectives are in accord with the objectives of a typical physical education program in any educational setup. Without question the military demands required stress on formal procedures and on the development of stamina and endurance, to a greater degree than would ordinarily be demanded.

SPECIAL METHODS

A challenging feature of the Air Force training program was the call for methods of presentation of subject matter different from those to which the instructors were accustomed. As a consequence, departmental staff meetings were held often and were found in most cases to be very inspiring. In the opinion of the coordinator, those in history were particularly valuable.

(HGM) English: The cadets' scarcity of time for preparational study forced upon students and instructors alike accomplishment during the class hours. Some of the instructors were surprisedly enlightened on the gain in accomplishment when minutes were precious—too precious for expenditure on side-issues, on interesting but hardly relevant discussion. Desire to have the hours pass with something like military precision also contributed to accomplishment. And this same lack of time forced instructors to use methods that set the cadets themselves to work, singly and especially as a group. For instance, the appointment of student critics of speech, or of a leader of panel discussions and participants with the audience primed to question and criticize, placed responsibility upon the students. The lack of time also reduced discussion of theory by the instructor to the minimum and led to putting it, rather, on mimeographed sheets of paper, and urged employment of applications of it in the classroom.

(GDS) Physics: We were advised by the army authorities that the training in physics should consist of classroom instruction and laboratory experiments. Our limited supply of apparatus gave no hope of carrying on individually performed experiments due to the large number of students and we were forced to a rather rich program of demonstrations that were carried on by the instructors and a limited number of students before the whole class.

We were of the opinion that for the concentrated instruction required for this program, classroom demonstration would be better than individual student experimentation because individual student experimentation is time consuming if it is to be effective.

(WES) Physical Education: There were no new teaching methods employed which have not been used by physical education teachers for many years. The program consisted largely of getting back to basic principles which at one time were the only ones employed. In other words we got rid of the frills and "mollycoddle" devices which have been in use to appeal to the phychological side of the student rather than to build him up. The army and the army discipline were very largely responsible for this. I am of the opinion that college authorities should study the methods carefully with a view of utilizing some of them in future years.

(NJL) Mathematics: The chief objective of the aviation cadets in studying mathematics was to learn to use certain "tricks" in obtaining practical results in a narrow and sharply defined field of application. Our first step was to practice on ordinary arithmetic, with special attention to strange units used in connection with aviation. We also solved a large number of verbal problems involving ordinary arithmetic and a very little algebra. In all this there was little strange or new. The sharp requirement for a very high degree of accuracy did, however, introduce a slight degree of novelty.

The point is that we compromised with the severely logical procedure of formal mathematics. We used all available ways of obtaining common sense insight. That developed a type of "understanding," often deeper for our purpose than that which comes from rigorous proofs.

CHECKS ON ACCOMPLISHMENT

By means of an interesting and complicated statistical process, Santa Ana attempted to evaluate the progress made by trainees of the various detachments. As a result, this institution was requested to analyze the process by means of which it succeeded so well in mathematics. The department, in attempting to make this analysis, agreed that the factors which weighted most in our success were, briefly stated, the following:

1. Each class was carried on independently at the rate best suited to its ability.

2. In the final month of training, whenever opportunity offered, mathematics classes were conducted, the content of this final work being largely the story problem.

3. A fine spirit of cooperation pervaded the teaching force, practically daily opportunity for comparing notes being available.

4. The attitude of the instructors toward the difficulties of the trainees was excellent.

5. This department was fortunate in having a good knowledge of the actual mathematics required in the technical ground school subjects in aviation training.

6. Text books were supplemented by numerous mimeographed sets of tests and exercises, these sets being made up by cooperation of the entire staff.

There must remain some question of the effectiveness of the Santa Ana process of measuring accomplishment.

(WPC) History: The final tests were made and given from headquarters, not by us. We made our own weekly tests, however. I was never allowed to see a single example of the kind of test I was preparing the men for. History is a big subject. The time allowed these men to learn it was short. I could have better prepared them for their final tests if I had known what the tests were to cover and where the emphases were likely to fall.

LESSONS FOR THE FUTURE

(JM) English: Clarity of objectives, concern for practical essentials, the inevitable pressure of time which made often for better, more precise teaching, —these are certainly lessons to be learned and put to profit. There are cautions though. What one may learn against this background of Army discipline may all too often carry into the academic atmosphere where the parallel may not follow with the same exactness. The job is a larger one in academic teaching; the discipline is internal; the objectives often far away and of necessity vague. We are asked to accomplish many things: ability to read well, to write clearly, to speak with accuracy and fluency, to know the pertinent facts of one's own language, to know something of the processes of clear thinking, and to know, above all, the necessary tool-aptitudes in the language to enable the student to do good work in all his courses.

(NJL) Mathematics: This matter of bringing out and using the common sense properties of the figures is something to which, in our formal courses in our schools, more attention may well be paid. Too often pupils "prove" theorems in a formal way without knowing what the real substance of the theorem is; and far oftener they miss the element of direct insight that was easily brought out and used effectively in our work with the aviation cadets.

It is not at all unlikely that important modifications in our way of teaching geometry may result from these brief courses taught to these young men.

(EK) Mathematics: It is probably better to teach a limited number of topics thoroughly than just to "cover ground" on a larger number of topics. The curriculum outline provided in the program called for covering topics ranging from arithmetic computation to the use of the sine and tangent formulas in trigonometry—all in five months. Many of the students had taken only the algebra and geometry found in the usual high school program, while some had never studied mathematics in high school at all. The question naturally arose as to whether teachers should try to "cover" the outline called for regardless of the learning ability of the students, or whether they should advance only as rapidly as the material could be learned. The decision was made for the latter course of action. Some flights covered the entire outline and even went beyond its scope; others barely advanced into the field of algebra computation. But all the flights had developed reasonable competence in the materials as far as they had gone. The justification of this policy came when the students were tested at Santa Ana, and those from Montana State University ranked second in mathematics among those from some 42 colleges and CTD centers.

It is important to devote class time to helping individual students. Considerable time was given to "seat work" during the class periods. Instructors were

able to clear up difficulties not raised in general discussion. In some classes instructors enlisted the help of the more capable students in the group for this purpose also. Almost every student has difficulties which are unique to himself. Individual conference provides about the only way of spotting these difficulties and helping students overcome them.

More attention needs to be paid to arithmetic reasoning. Even students with previous work in college mathematics encountered difficulties in reasoning arithmetically. This would imply that mathematics teaching for general education in our high schools be straightened in the area of simple arithmetical reasoning, especially in relation to percentages and fractions.

(GDS) Physics: In summarizing, let me say first, that in spite of the difficulties set forth above, we did teach these people a lot of subject matter. This is proved by the showings that students made on tests given at the time of entrance and tests when they were about to leave us. The showing that these students made on these tests is one of the bright spots of the program.

A by-product that was developed in this program was the improvement of the teacher. Unquestionably our instructors were improved by becoming acquainted with the subject matter, by cooperating where close cooperation was required.

The program would have been more effective if there had been more time for the student to study on his own. I question the long range value of any system of instruction in which the student has opportunity to learn only in the class room.

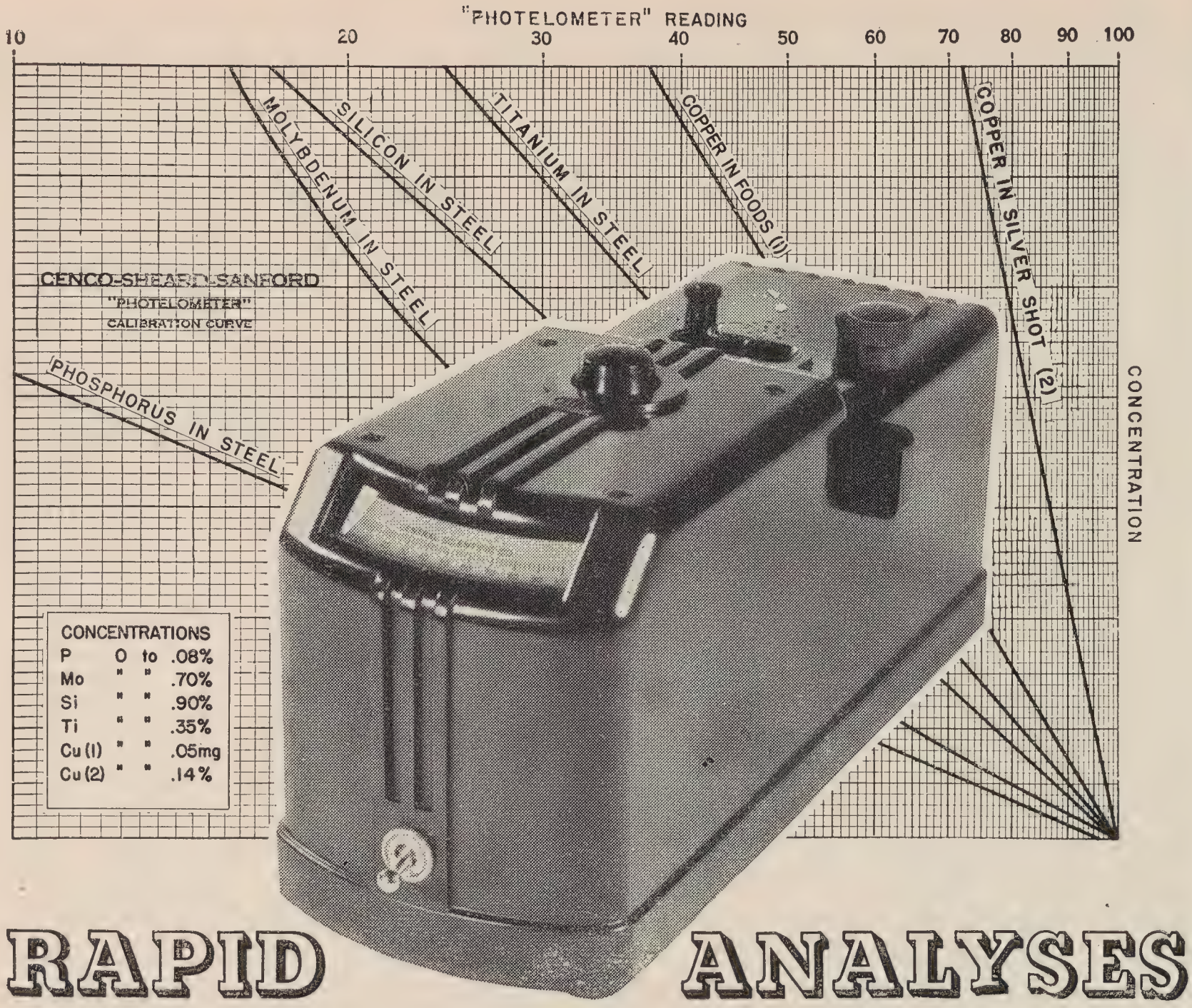
The program would have been more effective if we could have sorted students for uniformity of background.

(WES) Physical Education: It seems to me that college authorities could well profit by the lessons learned from army methods. I believe some of the methods used could be utilized for the betterment of both teaching and relationship between teacher and student. Also I think that it might be well to have these things in mind and place before Army and Navy authorities the advantage of combining compulsory training with education.

(CFH) Physical Education: In an overall picture, it may be said that the A.A.F. program would closely correlate with the objectives and organization of the average educational program of physical education with the following exceptions:

(a) Education does not demand the strictly formal procedure necessitated by the Military Service.

(b) An education program is broader in scope and embraces many more activities than were given in this program with less stress on the development of stamina and endurance.



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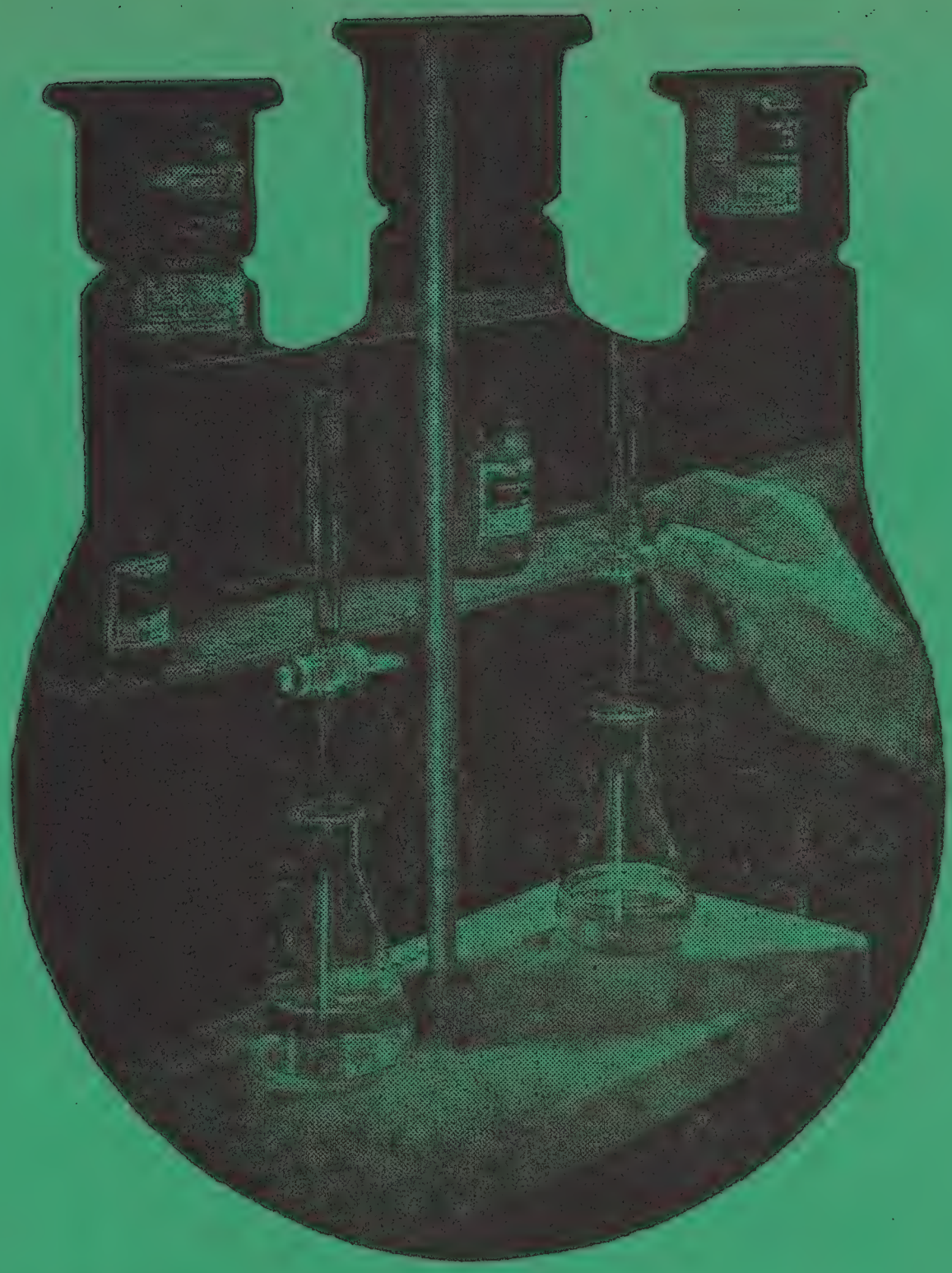

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NORTHWEST SCIENCE

August, 1945

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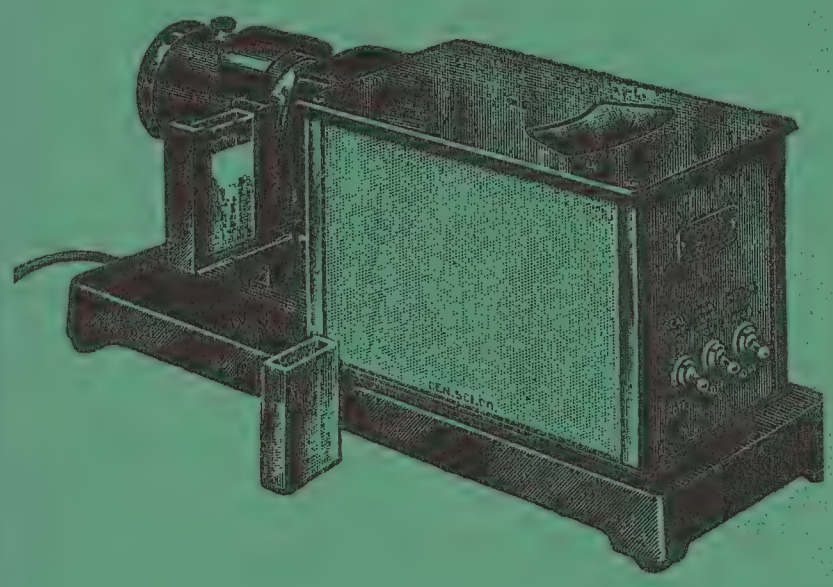

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL. XIX No. 3 AUGUST, 1945

Editor, W. R. HATCH, State College of Washington

ARTIFICIAL RESEEDING AND THE CLOSED COMMUNITY

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INTRODUCTION

To be successful in increasing the grazing value of western range lands through artificial reseeding, certain ecological principles must govern action. Recent studies by the Intermountain Forest and Range Experiment Station have shown that lack of general recognition of what might be called the "closed" community principle accounts for frequent failure in attempts to reseed some range types. Closed communities, that is, established stands of vegetation that fully utilize the habitat, are not readily invaded, and mass invasion, without adequate opening of the community by some external agent, is practically impossible.

The inherent capacity of plants for growth and reproduction leads to competition for every available niche in each habitat and results in a universal tendency for all plant communities to become closed. This competition has fundamental application in reseeding, and indeed in the entire management of range lands.

Communities of one species, or of a few species having similar requirements, are invaded more readily because the plants are unable to monopolize the limiting factor, usually moisture, throughout the growing season. Opportunistic species may complete their critical period during the interval of excess moisture. Obviously, full use of all factors is more nearly possible by a mixture of species having unlike life forms and rhythms. Communities having drought-evading and drought-enduring dominants are sometimes subject to widespread, partial invasion by drought-escaping species. This is exemplified by the advent and persistence of *Bromus tectorum,* a European annual, in the northern desert shrub association, even under good management.

The concept of the closed community, however, is not inimical to that of plant succession. Primary plant succession is normally a slow process; rapid changes occur during secondary succession when some disturbing factor such as wide climatic fluctuations, fire, or biological activity opens the community to mass invasion. Continual operation of any of these factors may hold a community open indefinitely. Overgrazing on loose soil is a case in point.

In arid or semiarid climates, closed communities are periodically thrown open to partial invasion by marked departures from the established climatic norm. Thus, catastrophic drought lays open ordinarly stable communities—and even the climax vegetation—to invasion (3, 5). Possibilities for invasion are obviously excellent when killing drought is followed by abundant precipitation.

During gradual and cumulative range deterioration, the community remains virtually closed to mass invasion. Frequent and continued close cropping of the most relished plants first prevents reproduction and lowers their food reserves. This is followed by a gradual impairment of the root systems. One by one the better plants, now unable to draw moisture from a large volume of soil, or with insufficient reserve food to sustain respiration through a long period of dormancy, drop from the community. During the progressive decline of the best forage plants, their less relished and hence more vigorous neigh-

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Table 1.—Average plot ratings[1] of five perennial grasses planted in the BROMUS TECTORUM type from 1936 to 1939.

Species planted	Age of plot, years	Closed community		Opened community		Mean diff.[2]	Least significant difference (5% level)
		No. of plots	Mean rating	No. of plots	Mean rating		
Agropyron cristatum (Crested wheatgrass)	1	22	6.8	19	7.6	3.5	1.7
	2	22	4.0	23	6.2		
	3	25	3.8	19	7.3		
	4	14	3.6	5	9.4		
A. inerme-spicatum mixture (Bluebunch wheatgrass)	1	19	4.1	11	6.4	2.0	2.1
	2	18	2.4	13	3.1		
	3	17	1.9	9	3.9		
	4	13	2.5	4	4.2		
A. trachycaulum (Slender wheatgrass)	1	12	4.4	9	5.9	2.6	4.2
	2	11	1.2	10	3.0		
	3	10	1.0	6	3.6		
	4	7	1.0	3	3.0		
A. smithii (Bluestem wheatgrass)	1	14	4.1	11	3.5	1.8	3.1
	2	13	0.8	11	1.4		
	3	9	1.0	5	2.8		
	4	6	2.1	3	1.3		
Poa bulbosa (Bulbous bluegrass)	1	15	4.7	14	4.4	0.0	
	2	18	3.0	13	3.5		
	3	10	4.8	9	4.8		
	4	6	6.2	3	3.7		

[1]On a scale of 10 as follows: 0, failure; 1-2, very poor; 3-4, poor; 5-6, medium; 7-8, good; 9-10, very good.
[2]Shown only for 3-year-old plantings, the oldest for which a reasonably adequate number of plots are available.

bors extend their roots to the newly available supplies of moisture, a development often reflected in their increasing height, density, and fecundity. New individuals or species of low value may also slowly invade. The end result is commonly the firm establishment of only those species having the minimum grazing value. Total density of cover sometimes actually increases during the process owing to great increases in low-grade components. This downward trend may continue for years or decades, the duration depending upon the degree of grazing intensity, the climate, soil stability, floristic composition, the degree of change in physiognomy, and perhaps other factors.

The inability of even the best adapted species to invade such well-established closed communities as climax grasslands is to be expected. Writing from extensive first-hand experience in the northern Great Plains, where crested wheatgrass is eminently well adapted, Allred (1) states, "I have never seen a situation where crested wheatgrass has migrated into a climax stand of grasses or even produced competitive stands where it has been drilled into them." Areas fully clothed with climax grasses are seldom selected for artificial revegetation, but the closed community principle is scarcely less applicable to pastures or ranges depleted gradually yet so completely as to need artificial reseeding.

OBSERVATIONAL EVIDENCE

The Intermountain Forest and Range Experiment Station in a 5-year period (1936 to 1940 inclusive) made numerous, widely scattered plantings of five promising species in the *Bromus tectorum* and depleted *Artemisia tridentata* types of Utah, Nevada, and southern Idaho. Nearly all the plantings were in the zone of 8- to 15-inch winter type precipitation, at elevations of 4,700 to 8,000 feet, and on areas ranging from 1/100 acre to 10 acres.

Some of the plantings in each problem type were made without eliminating the dominant species; in others, those species were partially or completely eradi-

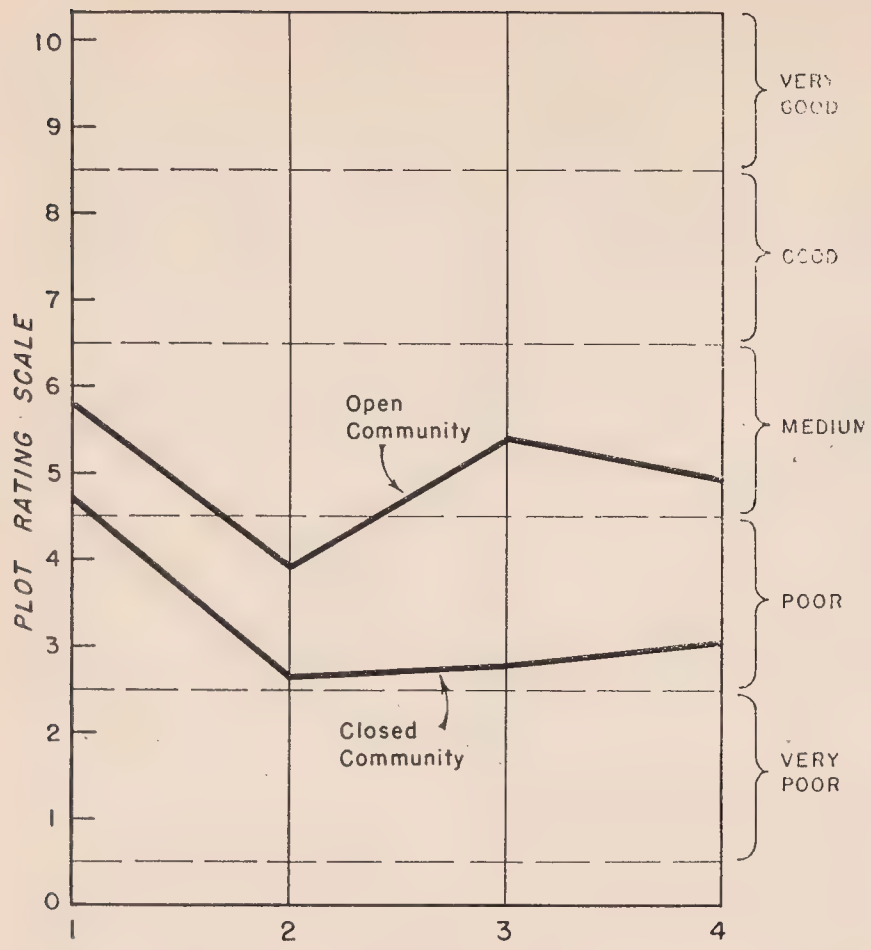

Fig. 1—Average success ratings of plots planted to five perennial grasses in open and closed *Bromus tectorum* communities.

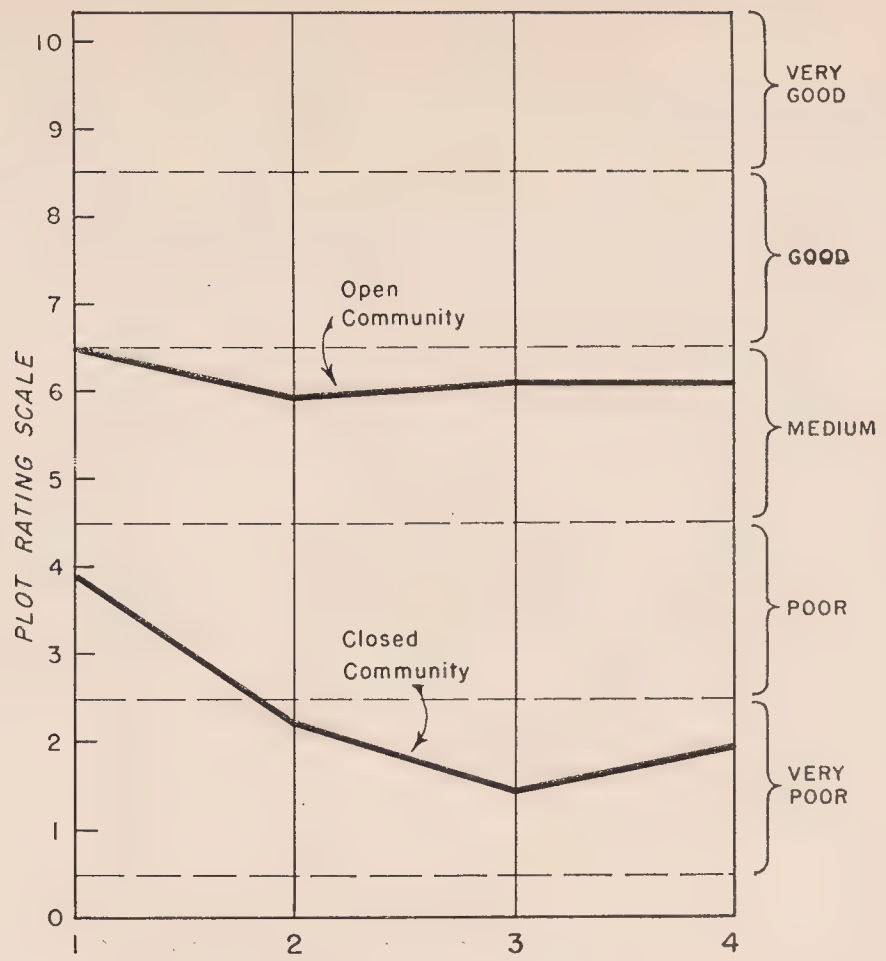

Fig. 2—Average success ratings of plots planted to five perennial grasses in open and closed *Artemisia tridentata* communities.

cated, usually at the time of seeding. Reduction on stand of B. *tectorum* was by plowing, disking, or springtooth harrowing. Drilling was the common method of seeding, but in several studies broadcasting was practiced followed by hand-raking, disking, harrowing, or no treatment to cover the seed. Eradication of *A. tridentata* was by various methods and in various degrees of completeness. The commonest methods were hand-grubbing, burning, and plowing; railing and scraping were less used. Many plots were drilled, while on others the broadcast seed was covered by settling of freshly disturbed soil, by harrowing, disking, or hand-raking. On still others no covering was attempted.

The plots were examined each year, in June if possible, until the degree of success was known. At each inspection, observations of the vigor of plant growth, distribution on the plot, stage of development, reproduction, and factors contributory to these conditions were recorded. Average height, diameter, and number of plants per square foot were also noted. On the basis of these observations each plot was given a success rating on a scale of 10 as follows: O=failure, 1-2=very poor, 3-4=poor, 5-6=medium, 7-8=good, and 9-10=very good. A rating of 10 indicates uniform distribution with high vigor and sufficient density to dominate the plot at such a time as the seeded forage reaches maturity.

The data showed that in the *B. tectorum* type, sufficient disturbance to open the community is in general necessary for the establishment of reseeded species (Table 1, fig. 1). Only one species, *Agropyron cristatum,* made satisfactory stands and reduction of competition clearly contributed to its successful establishment. The average rating of 4-year-old plots of this species was poor (3.6) in the closed community compared with very good (9.4) in the opened community. Most other species produced unsatisfactory stands at best, but made better showings in the opened than closed community. *Poa bulbosa,* a very early growing, drought-evading perennial, appears to be able to invade established cheatgrass stands, but at a relatively slow rate.

In the *A. tridentata* type, the 114 four-year-old plots provide somewhat more reliable conclusions than was possible in the *B. tectorum* type where only 64 four-year-old plots were available. Even more strongly than for the *B. tectorum*

Table 2.—Average plot ratings[1] of five perennial grasses planted in depleted ARTEMISIA TRIDENTATA stands from 1936 to 1939.

Species planted	Age of plot, years	Closed community		Opened community		Mean diff.	Least significant difference (5% level)
		No. of plots	Mean rating	No. of plots	Mean rating		
Agropyron cristatum (Crested wheatgrass)	1	29	5.5	28	7.4		
	2	21	2.7	23	6.9		
	3	17	2.2	22	7.7		
	4	15	2.9	13	8.9	6.0	1.5
A. inerme-spicatum mixture (Bluebunch wheatgrass)	1	17	6.0	18	6.3		
	2	15	2.6	10	5.6		
	3	11	1.3	11	4.8		
	4	9	1.9	11	5.3	3.4	2.2
A. trachycaulum (Slender wheatgrass)	1	23	3.4	15	7.0		
	2	19	1.9	10	6.1		
	3	13	1.0	8	6.5		
	4	13	1.4	11	4.8	3.4	2.7
A. smithii (Bluestem wheatgrass)	1	17	1.1	13	4.8		
	2	14	1.5	9	5.2		
	3	12	.5	7	5.8		
	4	10	1.2	10	6.3	5.1	2.7
Poa bulbosa (Bulbous bluegrass)	1	22	2.4	13	5.2		
	2	18	2.0	7	3.7		
	3	13	1.5	7	4.0		
	4	12	1.5	10	4.7	3.2	2.0

[1]On a scale of 10 as follows: 0, failure; 1-2, very poor; 3-4, poor; 5-6, medium, 7-8, good; 9-10, very good.

type, the data suggest that undisturbed *A. tridentata* type is closed to artificial reseeding (Table 2, fig. 2). Significant differences between mean ratings of 4-year-old plantings in the closed and opened communities were found in each species. All species were favored by reduction of brush, especially *Agropyron cristatum* and *A. smithii*. The other species were evidently not well adapted to the site and produced less satisfactory stands.

EXPERIMENTAL EVIDENCE

While the data just presented were drawn from essentially random and fairly numerous plantings over the Intermountain region (Utah, Nevada, and southern Idaho), experimental control was not as close as desirable because most of the plantings were designed primarily for other purposes, such as species adaptability tests, or for demonstration. In an attempt to explain these observations, and as a further test of the theory that successful reseeding requires reduction of stands of *B. tectorum* or *A. tridentata*, a few studies with closer experimental control were made.

One of these was carried out on a moderately deteriorated *Artemisia* stand near Wells, Nevada. In 1937, twenty-four 1/100-acre plots were laid out around the edge of a small burn and seeded to single species or mixtures by broadcasting and raking. Twelve plots were in the brush and were comparable with 12 others located where the brush had been killed by fire. No trailing or grazing was permitted until the fall of 1941. On the average, the ratio of herbage production from the unburned and burned plots was 1:6 in 1939, 1:12 in 1940, and 1:6 in 1941 (Table 3). Such differences spell the difference between success and failure in artificial reseeding.

In a study near Wells in 1939, several methods of planting were compared. These included drilling after burning the brush, and broadcasting after scarifying with a road ripper at 2-foot chisel spacing. Brush kill on the burned plots was over 90 percent, compared with

Table 3.—Average yields of reseeded species on burned and unburned plots in ARTEMISIA type near Wells, Nevada.

SPECIES	No. of Plots	HERBAGE YIELD, POUNDS PER ACRE								
		1939 (Green wt.)			1940 (Air dry wt.)			1941 (Air dry wt.)		
		Unburned	Burned	Ratio	Unburned	Burned	Ratio	Unburned	Burned	Ratio
Agropyron cristatum	10	22.2	252.6	1:11	42.6	447.8	1:11	75.6	429.6	1:6
Agropyron inerme	2	119.0	109.3	1:1	19.4	292.5	1:15	10.5	389.6	1:37
Arrhenatherum elatius	2	218.2	48.5	4:1	4.8	70.1	1:15	2.0	52.7	1:26
Bromus inermis	6	4.9	428.8	1:87	7.1	299.6	1:42	16.8	239.7	1:14
Mixture	4	16.1	157.6	1:10	64.7	504.4	1:8	127.7	318.9	1:2
All plots	24	41.3	251.9	1:6*	32.3	375.8	1:12†	58.0	328.9	1:6†

*Difference between means sifnificant at 5% level.
†Difference between means significant at 1% level.

about 20 percent of kill resulting from ripping. Both methods gave satisfactory stands of seedlings the first year, 1940. In 1941 and 1942, though the area was closed to stock, severe grazing by jackrabbits retarded the development of the plants and caused some mortality, especially on the burned plots. Measurements showed that after the first year, the ripped plots supported twice as many grass plants as those burned and drilled, owing in part to protection from rabbits afforded by the brush (Table 4). However, the individual plants on the burned plots were four to five times larger, resulting in considerably greater forage production where brush competition has been completely eliminated. Evidence from another study indicates that the fertilizing effect of ashes has little if any influence on total growth where moisture is so limiting.

Another significant result from this experiment is the rapid response of *Artemisia* to partial opening of the community. During the unusually dry growing season of 1940, *Artemisia* on the undisturbed check plots which were not seeded to grasses made very little growth, only occasional plants flowering. Brush plants in the disturbed plots and along margins of burned plots were conspicuous for their growth and seed production.

Similar results were obtained at the Santa Rosa substation near Paradise Valley in 1943. Strips 9 feet wide and 210 feet long were cleared by hand grubbing through an *Artemisia* stand. The next season, *Artemisia* twig growth

Table 4.—Density and yield of grasses artificially seeded in ARTEMISIA type following brush eradication.

Method of planting	Approximate eradication	Number of plants per square foot				Herbage yield (Lbs. per acre air dry)	
		1940	1941	1942	1943	1943	1944
	(Percent)						
Burned and drilled	90+	1.5	0.6	0.5	0.4	113.8	328.4
Ripped and broadcast	20	1.6	1.2	0.9	0.9	52.8	132.2

Fig. 3—Regrowth of crested wheatgrass in a sagebrush clearing at the U. S. Sheep Experiment Station, Dubois, Idaho. This once-vigorous stand has been grazed to the ground each spring of the past 3 years. It shows no mortality although being invaded by sagebrush seedlings. U. S. Forest Service photo.

was 70 percent, and inflorescence 55 percent longer within 5 feet of the grubbed strip than 30 feet away.

This ability of *Artemisia* to respond to disturbance, to re-enter competition, and to avail itself of extra moisture is further shown by observations of root regrowth following root pruning at elevations of 5,800 feet and 5,200 feet in northern Nevada. At the higher elevations, brush roots pruned in late August 1940 were dormant on May 15 but when next observed on August 15 had recovered much of their former spread (4). Root regeneration following pruning in the early fall of 1942 was in progress by the following mid-April at the lower elevation.

Grass in competition with sagebrush succumbs more quickly to grazing than where this competition is absent. A pasture at the United States Sheep Experiment Station near Dubois, Idaho was partly cleared of sagebrush 11 years ago and seeded to crested wheatgrass. The resulting stand was managed to encourage firm establishment of the grass, with good vigor apparent both in the clearings and amidst the brush. During the past six springs, sheep have been held on this pasture until all the accessible grass was leveled to the ground A general weakening of the wheatgrass now is indicated by the presence of invading sagebrush seedlings. However, mortality and absence of summer regrowth are common only near the brush (figs. 3 and 4).

Phytometers were used to study open and closed communities under much closer experimental control than is possible in larger natural communities. *Helianthus annuus* was planted in cans containing equal weights of well-mixed clay loam of uniform moisture content. After germination, plants in excess of 10 per can were removed. Equal amounts of water were supplied the phytometers so that slow but continuous growth was maintained. When the plants were 4½ inches tall, two containers were chosen at random and thinned to the four best plants. A second planting of four sunflower seeds was then made in each of the four cans. Frequency of watering was increased to favor germination.

The height growth of both the first and second plantings of sunflowers

Fig. 4—Lack of regrowth, mortality, and invasion by sagebrush seedlings characterize the patches of crested wheatgrass in small sagebrush openings where utilization has been the same as on other parts of the U. S. Sheep Experiment Station pasture illustrated in the preceding figure. U. S. Forest Service Photo.

clearly indicated the suppressive effect of the closed community (fig.5).

On October 3 watering was discontinued. By noon, October 6, the younger sunflowers growing in cans with 10 older plants—the closed communities—were either dead or permanently wilted. Those growing with only four older plants—the open communities—had ceased active growth but were erect and turgid.

In this experiment the original plants were capable of using most of the meager supply of water. Thinning the stand allowed the new plants to obtain sufficient vigor to survive when soil moisture became critically low. In certain ecological relationships and results, this experiment closely parallels attempts at reseeding in stands of well-established vegetation with and without opening the community.

DISCUSSION

Observational and experimental evidence indicates that well-established stands of *B. tectorum* and *A. tridentata* in the Intermountain region are essentially closed to mass invasion. Soil drought is doubtless the obstacle interposed by the closed community. Soil moisture determinations made near Paradise Valley, Nevada, showed that eradication of the stand of 4-foot *A. tridentata* and cultivation prolonged the period of available soil moisture in the upper foot of soil by as much as 7 weeks. This is significant in the light of recent studies of seedling root development in northern Utah (2). On June 6, only 4 of 10 species of range grasses planted the preceding fall had developed roots to a depth of 1 foot or more.

In the area covered by this study, the precipitation pattern generally assures adequate moisture for spring growth of seedlings. During the late spring, summer, and early fall, when 2 to 4 months without effective storms are to be expected, soil moisture usually becomes so deficient that grass seedlings cannot survive the competition from established species.

By virtue of its vigorous spring growth, *B. tectorum* in dense stands draws heavily on the soil moisture provided by winter snows and spring rains by the time it matures seed. Moisture is

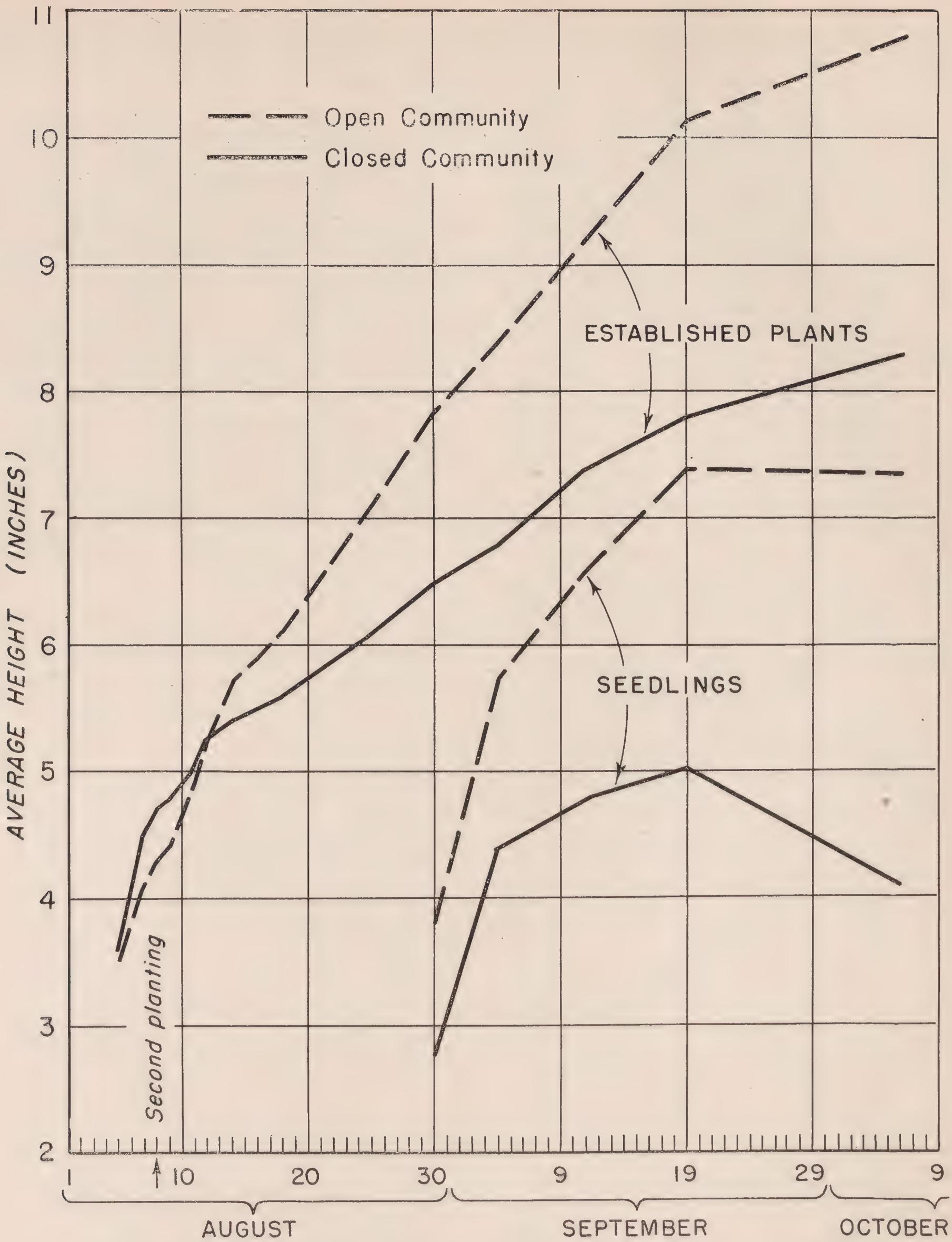

Fig. 5—Average growth curves of *Helianthus* in equally watered phytometers treated to simulate reseeding in open and closed communities.

then not adequate to sustain the slower growing perennial grass seedlings through the normally dry summer and fall. Any effective summer rains that occur after the *B. tectorum* plants have become dormant are available for the perennials, and this may explain the successful reseeding in established *B. tectorum* stands in occasional years, or in regions with considerable summer rainfall.

A. tridentata influences the moisture relationships in a number of ways. Obviously the brush reduces insolation, wind movement, and evaporation from the soil surface. It is also said to retain snow, to hasten infiltration, and to retard surface runoff.

However, an *Artemisia* cover induces earlier usage of water in some instances. By acting as black body radiators, the shrubs hastened the melting of snow in the spring of 1942 by as much as 2 weeks at Paradise Valley, Nevada. Dissipation of the limited supply of stored moisture thus commenced earlier under a sagebrush cover than in brush clearings, an effect which may offset the protective reactions. The greatest water loss no doubt results from year-long transpiration.

Successful seeding in closed communities of *B. tectorum* or *A. tridentata* is an exception rather than the rule. Planting in such communities, without provision for reduction of competition from the low-value forage plants, entails a risk far out of line with the cost of treatments required to reduce such competition. The opening of closed communities by severe drought, uncontrolled fire, very severe grazing, and similar destructive forces is usually not considered desirable, but it frequently provides conditions favorable for artificial reseeding, provided sufficient soil remains. The land manager, therefore, should take advantage of such opportunities to establish a desirable cover by artificial means while nature is receptive.

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TERTIARY CONIFEROUS WOODS OF WESTERN NORTH AMERICA

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INTRODUCTION AND REVIEW OF LITERATURE

Almost four decades have elapsed since Platen (1908), the German paleobotanist, published his report upon the fossil woods of the western United States. Since then no over-all treatment of these materials has been attempted. although Platen overlooked the Pacific Northwest with its abundance of Tertiary petrified woods. The purpose of this paper is to bring knowledge of the western coniferous woods of the Tertiary up to date. In this effort the writer recognizes that much of this information has been accumulated incidentally in the study of the Russell Petrified Forest series of central Washington, and that it is not as complete as he might wish.

Platen's paper is written in German and this has limited its use among Americans. Furthermore, as is to be expected, its usefulness has diminished with time as more and more has been learned about modern woods and the critical anatomical details upon which they may be separated. Platen made no serious effort to reduce his types to modern genera and his descriptions are hardly adequate for that purpose today; nor are his type specimens available to us for review.

It is to be regretted that Platen failed to use the then new ray-cell pitting method of Gothan (1905) for establishing the main divisions of the Coniferae. Eleven years after the appearance of Platen's paper, Krausel (1919), a convert to Gothan's system, reviewed Platen's work and possibly his type specimens. Krausel is not always definite in his commitments, but he seems to have accepted several of Platen's types as counterparts of modern genera. He also accepted one of Gothan's California woods as the fore-runner of the modern Douglas fir *(Pseudotsuga taxifolia)*.

In the introduction to this key to the known coniferous woods of the western Tertiary, sometihng needs to be said in defense of the elaborate techniques and complicated system of nomenclature which are employed by the wood-paleobotanist. Since Witham (1833) first adapted petrographic thin-sections to the study of petrified woods, students have sought in vain for some short-cut and less tedious means to achieve the same result. Research upon fossil woods has also been handicapped by the lack of modern comparative materials in even the larger colleges and universities.

Finally there is the system of nomenclature. Much as one may object to the somewhat confusing and apparently artificial system of classification evolved by the wood-paleobotanist, one must admit in the end that the advantages of the system outweigh the obvious disadvantages. Probably no other branch of paleontology employs as cumbersome an array of multisyllabic and apparently contradictory terms, largely due to the extreme handicap imposed by high magnifications upon material typically poorly preserved. Furthermore, the wood-paleobotanist is dependent upon thin-sections not only difficult to produce, but which by their very nature can hardly be compared directly or studied in transitional series. Had the early workers failed to develop a generalized system of classification they would have been under compulsion to label most of their specimens as wood only.

The result has been an admixture of the artificial form-genus and the relatively real modern species concept. Progress is always being made towards the latter but too many woods of uncertain relationship appear to dispense with the form-genus entirely. The form-genus is of particular value as a label (1) for field specimens, (2) for imperfectly preserved specimens, (3) for single, isolated specimens, and (4), for anomalous or abnormal specimens.

Each student in turn has been required to review the evolution of this technical vocabulary not only for the evaluation of previously established generalized types, but also to understand the system of classification and mold it closer to any system in current use among wood technologists.

Not until the twentieth century did the modern genus find acceptance in the naming of a Tertiary American coniferous wood. Penhallow (1907 and somewhat earlier) applied the name *Sequoia langsdorfii* (Brngn) Heer—as previously applied to foliar remains—to woods he took to be obvious ancestral redwoods. Present practice would reject some if not most of these references (for want of traumatic canal rows), but some of them still stand and entitle Penhallow to credit for the innovation.

The evolution of the largely artificial system of classification employed in the study of fossil woods has its remote beginnings with Luidius to whom Ward (1885) gives credit for the coinage of the word "Lithoxylon"—literally rock-wood—in 1699. Since the time of Luidius the suffix *-oxylon* (frequently for hard-woods reduced to *-inium*) has been employed quite universally in the creation of form-generic names for woods bearing a real or apparent resemblance to a given modern genus, or group of genera.

Witham, the accepted father of wood-paleobotany, created no categories for Tertiary woods that have continued in use to the present. Even Goeppert (1850), master paleobotanist of all time, has left but one term in current use—Cupressinoxylon—an unwieldy but very useful reference for woods of generalized cedar (cypress) structure. Goeppert, himself, according to Krausel (1919) despaired of ever being able to recognize the precise modern generic counterpart of a fossil conifer.

In the 1860's Kraus (Gothan, 1905) added the form-genus Pityoxylon for woods resembling the pitchy or pine-like conifers, and Cedroxylon for woods suggesting members of the fir group. Unfortunately the latter name suggests the cedar (cypress) of popular concept as well as *Cedrus* (cedar of Lebanon) of the fir alliance, from which Cedroxylon apparently takes its root. Kraus also revived Unger's Taxoxylon as a category for yew-like coniferous woods.

In 1905 Gothan gave science the term Piceoxylon for spruce-like woods formerly included with the pines under Pityoxylon. He also adopted Felix's Taxodioxylon for the woods of apparent *Taxodium* or *Sequoia* affinity which had previously been submerged in the more general Cupressinoxylon. Probably the greatest single contribution to wood-paleobotany has been Gothan's segregation of the so-called "abietineous pitting" whereby the members of the fir alliance can be distinguished from other generalized woods.

The pioneering American, Penhallow (1907), like Platen failed to appreciate the discovery of Gothan, and therefore, today, we find Penhallow's descriptions incomplete. Only one American, Bailey, has made as notable a contribution to the science under consideration as the Germans previously cited. This author and his associates (1933, 1934, 1938) have made a number of studies upon the diagnostic features of living conifers. An attempt has been made to follow Bailey and his school especially as regards (1) their interpretation of abietineous pitting, (2) their concept of variability in tracheid pitting, and (3), their acceptance of wide variation in the cross-field pitting of the Cupressinoxyla. In respect to the third of these items I have felt constrained to drop all of Gothan's sub-divisions of the form-genus Cupressinoxylon save Taxodioxylon; but reviving Unger's Thujoxylon for cedar-like woods exhibiting a low maximum height of ray, and restricted (1, rarely 2) seriation of the tracheid pits.

Very welcome contributions to this study have been made recently by S. J. Record and his school concerning the variable thickness in transverse and end walls of the ray cells in living Cupressinoxylon types (Pierce, 1936,

1937). Usefulness of this feature is often minimized by loss of the secondary ray-cell wall, in whole or in part.

The present report is based upon an evolving fund of information coming in its main lines through the sequence Witham — Goeppert — Kraus — Gothan —Krausel—Bailey. I am particularly indepted to I. W. Bailey for his many kindnesses, and to S. J. Record for the generous loan of the Yale thin-sections of modern woods. Also this work would have been seriously handicapped but for the use of the Hough collection of modern wood slides made available through Ralph W. Chaney of the University of California.

In the key, the writer, like previous workers, has found it necessary to redefine the form-genera according to the extended or limited use to which each has been put. Five of these (not to include Ginkgo) are divisions of the first order: Cupressinoxylon, Pityoxylon, Cedroxylon, and Coniferoxylon. Coniferoxylon is a version of the form "Coniferites" used by Cramer (1868) for an indeterminate Greenland wood. In this treatment the term has been expanded to include anomalous woods —especially the Ft. Union specimens from Beach, North Dakota (Felix, 1886). In the second order stand Taxodioxylon, Piceoxylon, Thujoxylon and Spiropitys —the last named being a revival of one of Goeppert's form-genera.

(To be continued in next issue)

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AN EXPERIMENT IN EDUCATION: THE ARMY SPECIALIZED TRAINING PROGRAM[1]

OREGON STATE COLLEGE

E. B. LEMON

Coordinator of Military Programs, Oregon State College

In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in Your Military Training Programs for Science Education; for Education in General?*

Oregon State College has had an extended and varied experience with the Army Specialized Training Program. The Oregon State College unit was the first to be activated in the Ninth Service Command. The program has been in continuous operation on the campus since March 1943. It has included both basic and advanced phases of engineering, area and language, the 9A or graduate program, and the reserve for seventeen-year-olds. The total number of different soldier students who have participated to date is 3,022. The largest number in attendance at any one time was 1,354, and the smallest 167. For the current term, 419 advanced engineers and reservists make up the enrollment. The length of time individuals have been in attendance has varied from a few weeks to five terms.

If the language and area group had been permitted to continue long enough for the men to attain proficiency, it would have been a most interesting experiment. The program consisted of a language and the geographical, historical ,and sociological characteristics of a section of a country where that language prevails. This concentrated method of study, including the conversational approach to the language with much drill under native speakers, was unique. It has probably attracted more attention and comment in educational circles than any other phase of instruction in the ASTP. It seems to be rather generally conceded that where such a high degree of concentration in a given field is feasible, it is an effective means of instruction. Its civilian use, however, is limited since it is seldom feasible to present a typical curriculum on a subject-at-a-time basis. Furthermore, the number of instructors and size of sections employed by the Army do not fit into the civilian pattern except in rare cases.

The reservists (seventeen-year-olds) presented an entirely different problem. Faculty people are close enough to war and to young people to appreciate fully the position of a boy of eighteen who must suddenly break family ties for life in a military training camp. The opportunity for service to the reservist was therefore apparent. Three to six months on a college campus might do much to mature these young men and to prepare them for the next step ahead. For these reasons, instructors were readily in sympathy with the program. Nevertheless, it had its shortcomings. The difficulty that confronts college freshmen needs no review here. The gap between high school and college is not easily bridged, even under ordinary conditions. The reservists were freshmen, but freshmen in a situation that provides no machinery with which to build the bridge. The Army handled them as soldiers in uniform, and they received the respect and attention the young soldier commands in these times. As a matter of fact they were not soldiers because they had not been inducted into the Army. They came directly to the campus from their homes but received the uniform rather than the customary green cap. There was not injected into their early college training any of the deflating elements that usually characterize the experiences of freshmen. They were in no sense uncooperative, but in the classroom the high school atmosphere was ever in evidence. In

[1] This is the eighth article in this series. Copies may be secured from J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

spite of these shortcomings, the faculty who came in closest contact with these youngsters approve the program and are of the opinion that a good service was rendered.

The administrative machinery already in operation at the institution was employed to direct the Army teaching, the only exception being the appointment of a coordinator as required by the Army. All of the faculty engaged in the program were responsible to the coordinator through normal channels. Oregon State College has long been organized into a number of schools and divisions. For the most part courses required by the Army fell within three of these: Lower-division Liberal Arts, School of Science, and School of Engineering. The deans of these three schools together with some department heads working under the direction of the coordinator of military instruction constituted the administrative faculty. Frequent sessions of this group were held in the coordinator's office. From the beginning, the cooperation of these officers with the program and with the commandant and his staff was commendable. In the original negotiations with the Army contractors providing for the establishment of the unit, it was the understanding that approximately five hundred men ready to start the advance-phase engineering course of study would be received. This was regarded as an ideal arrangement. Plans were made for the required number of sections in the various subjects, and instructors in the respective fields were assigned to this proposed project.

But it was not as simple as first anticipated and planned. When the young soldiers arrived, three hundred eighty-three instead of five hundred came. As interviews preliminary to formal registration were held, it was soon discovered that this group was not uniform in preparation—not, for example, like a group of sophomores who had completed their freshman year. They represented such varying levels of preparation that when registration was completed five programs rather than one were necessary. This experience emphasized the urgency of an efficient counseling program as a definite part of the Army instruction, and was the beginning of a phase of the work that we now believe is one of the most basic factors in any particular success that may have been achieved.

Evaluation of the Army program with reference to adaptation to use in future civilian teaching is presented in the form of opinions of different staff members closely associated with the programs under four specific topics as follows: (1) effects of acceleration, (2) effects of streamlining subject matter, (3) carry-over values, (4) student motivation. Quotations from faculty members are identified by initials preceding each quoted statement.* Even before reaching the campus, the student soldiers had been impressed with the value of subjects such as mathematics and physics. Orientation lectures were not necessary to convince them that these subjects along with all other training in engineering were vital. Perhaps for these reasons such subjects and fields of study commanded more attention than the social sciences or even chemistry.

*GWG, George W. Gleason, acting dean, School of Engineering; ECG, Earl C. Gilbert, chairman, Department of Chemistry; SHP, Sigurd H. Peterson, head, Department of English; JWE, Joseph W. Ellison, head, Department of History; WW, W. Weniger, head, Department of Physics; CLC, Charles L. Clark, assistant professor, Department of Mathematics; CVL, Clair V. Langton, Director of Physical Education.

ACCELERATION

(*GWG*) *Engineering*: It is recognized that a speed-up in instruction was necessary. However, from the standpoint of civilian instruction, particularly in the postwar period, the majority of the engineering societies condemn the practice. It takes time to assimilate technical subject matter, and a certain amount of integration must be accomplished with either experiences of the student or instruction in industrial practices. The accelerated program permits no such integration; consequestly, the students are presented with various blocks of information, fundamental or otherwise, with little opportunity to understand the purpose behind the presentation of such bodies of information.

There is a marked tendency on the

part of the students to go stale. After a few periods of ASTP, any initiative that is originally displayed by the trainee is rapidly submerged in the necessity of completing daily assignments. Responsibility on the part of the trainee to accomplish work without the same being definitely assigned is lacking. The pace of the accelerated program is so rapid that there soon develops a general attitude on the part of the trainee that if he accomplishes a reasonable portion of the assignment, he has completed all that can be expected of him. Acceleration is also responsible in part for inadequate preparation at the lower levels for more advanced subject matter.

(*ECG*) *Chemistry*: In chemistry, the speed-up consisted merely of reducing the allotted time to two terms, without correspondingly increasing the number of recitations. Any speed-up could therefore be accomplished only by deletion of subject material, or increase in size of assignment. In addition the laboratory work was omitted entirely in the first term except for reservists.

In spite of this shortcoming of time, the textbooks recommended were the most difficult and lengthy, and it was evident from the scope of the final examinations that the course was supposed to cover the entire classical field of prewar chemistry. It seemed feasible therefore only to increase length of assignment (rather than delete or select material). Results obtained indicate that, combined with the same factor in other courses, such increase in material covered per recitation resulted in a loss of absorption by the student.

(*SHP*) *English*: Because most themes had to be written in class, as military correspondence had to be included, and because fewer class hours (as well as fewer outside study hours) were provided, a good deal of material regularly given in the civilian program (grammar and spelling, for example) had to be excluded. The general effect of the speed-up was not always good. One particular effect was the consequent lack of time for extensive reading in connection with composition and for "reflection" upon the material read. Most of the writing had to be done under pressure, and there was virtually no time for conferences with students. The instructors in this department would not wholeheartedly recommend a system of speed-up in composition courses for either civilian or military students.

STREAMLINING

(*ECG*) *Chemistry*: The objectives of the course in chemistry as stated at various times seemed to include its use as a basis for premedical and predental advanced chemistry; for a service course to engineering students; and to acquaint students with chemical aspects of military materials and processes. Further evidence of this lay in the ground covered by the final examinations passed by the Army, from which could be judged the concept of the governing group concerning desirable course content and objective. With such a wide objective it is obvious that "streamlining" or selection of material was impossible.

(*JWE*) *History*: There was no streamlining of subject matter beyond a careful delimitation of the scope of each course. Such organization of material was beneficial.

(*SHP*) *English*: The effect of streamlining upon the subject matter was in general to make the course more nearly approach the older composition course. In contrast to the present tendency toward much use of a "practice" or "work book," the army courses threw the emphasis upon analysis of effectiveness in structure and usage.

(*GWG*) *Engineering*: When technical matter is condensed to its bare fundamentals, it loses much of interest. This is particularly true in those subjects where the application of the fundamentals is necessary in order to understand their importance. The condensation process has resulted in a very definite lack of correlation or integration. For example, there is no opportunity in any of the advanced programs in engineering to reemphasize the principles learned in basic chemistry. In the initial stages of

the program, condensation resulted in gaps, as for example, instruction in the use of the slide rule. Most recently this has been corrected by including Engineering Problems in the E-1 course, but throughout the major portion of the program the students have been under a handicap in subjects involving calculation.

CARRY-OVER VALUES

(*SHP*) *English*: Since the course gave the student instruction in the various procedures of analyzing, presenting, and reporting processes, mechanisms, organizations, ideas, and experiences, the training received by the student from the course should have some carry-over value and use in any occupation. It might be said that the student also received some practice in speaking before groups.

The course offered basic training (and somewhat more, perhaps) in the principles of oral and written composition. For this reason, it should receive credit toward a degree.

(*WW*) *Physics*: Unless too long a time elapses before the students are returned to civilian employment, there may be some carry-over in case the employment is based on physical principles. There should also be some carry-over into problems of everyday life. As the work taught was of regular college grade it should apply toward a college degree.

Somewhat off the topic, but related: It will be a mistake to infer that returned soldiers can go on to advanced work that depends on physics. Some sort of a refresher course will be necessary for those who return to college. Two of our former students who are now officers in the Army each made the statement that what they will need when they return is a sort of "review and new" course that will get them back into the study habit. These fellows were both applying physical principles, but feel they need a course as indicated.

(*GWG*) *Engineering*: Since ASTP students were a highly selected group, and since they possess much native ability, the training that they have received will probably be entirely satisfactory for them to engage in industry along lines compatible with their studies. Whatever deficiencies are evident in their college training will probably be made up by further study in school or by interest on the part of the individual.

Although the technical training obtained from the program is not on a par with civilian training, it is believed that full college credit for the work should be given, as the ASTP students will have received as much benefit from their course as the civilian students in the lower bracket of a normal course.

It is unfortunate that the program has not permitted any personal development, nor has it developed any professional spirit.

(*ECG*) *Chemistry*: The course as we gave it should give engineers who were in the upper 75 per cent of the grade levels a sufficient basis for civilian employment. It would be useless for any employment requiring an actual working knowledge of chemistry.

Applying toward a college degree: For engineers who were in the upper 75 per cent, if there is not too great a time lag, the course as given could be regarded as meeting the requirements for the 3-term service course which they customarily take. This would not signify equality of content or in many cases equality of achievement, but would recognize the practical difficulty of providing one more term at some later date, which would serve any useful purpose.

We do not regard the course as a sufficient basis for further work toward medicine or professional chemistry, even though college "credit" may be given for it.

(*JWE*) *History*: For civilian employment—none beyond the customary objectives for studies in the social sciences.

Applying toward a college degree—the work, in almost all classes, was of college quality and merits college credit,

as follows: Basic Engineering, American history and ASTRP American history, lower-division credit; Area and Language history, upper-division credit.

MOTIVATION

(*WW*) *Physics*: In the earlier groups of soldier students everybody worked well. Later, when news was passed around to the effect that Officer Candidate Schools were closed, there was a decided decrease in effort. When news reached the campus that others who had done well in their scholastic work were placed in combat units, there was a still further decrease of effort. The hardest people to do anything with were the 17-year-olds. Many of these regarded their stay in college as a prolonged sinecure. The fact that they had not been inducted, and therefore did not consider themselves under military discipline, was the major factor involved.

On the other hand, many of the soldiers, even including some of the 17-year-olds, said that they appreciated what the Government was doing for them. About a dozen altogether came to me and told me that they had had hopes of attending college but no practical means of realizing that hope until the Army sent them here. These boys did everything possible to make a good record.

(*JWE*) *History*: This was a vulnerable point in both ASTP and ASTRP. The attitude of students, apparently reinforced by military official pressure, was that history, geography, English, and related studies were incidental and secondary and that languages, mathematics, physical sciences, and engineering must come first.

(*ECG*) *Chemistry*: It is our feeling that in the field of student motivation, this program faced its worst problem and found its greatest departure from the optimum.

It is obvious that since these men are or will be in the Army, the only incentive which will have any effect is that of military value in the way of Army advancement. Apparently the course of this war has been such that a long-time educational program could not be visualized and also no practical immediate objective demonstrated by their superior officers. Student morale, therefore, while generally high with an incoming group rapidly deteriorated to a place where the achievement level was below that of civilians taking equivalent material. This morale question was such that subject-matter instructors could give but little positive help.

(*GWG*) *Engineering*: Student interest has been maintained at a relatively high level in spite of certain difficulties. It could not be expected that the boys whose interest was in one branch of engineering when assigned to an entirely different branch would have the same enthusiasm. Lack of background preparation and attendant difficulties have been discouraging to many students. There has also been the tendency for leaders of groups to dominate and in a measure dictate so that student morale has fluctuated on a group basis rather than on an individual basis.

(*CLC*) *Mathematics*: On the whole, the organization of material and the results achieved in the AST Program are very impressive. On comparing experiences in other military programs such as V-12, meteorology, etc., this is perhaps the most successful objective. The pace is near the limit for maximum results. Sometimes there is insufficient time to investigate "why" as well as "how." Consequently, while the program achieves all its objectives, as a peacetime program it might fail in some respects: namely, the student may not retain as much, and research ability may not have been stimulated as greatly as desired. The first objection can be overcome to some extent by overlapping homework assignments and examination content.

For college credit, the courses might be evaluated more as to lecture time spent than to material covered.

More examples from applied science, use of Simpsons and Trapezoidal rules

in road construction, ship and plane building, etc., stimulate interest.

Daily homework on selected problems and frequent examinations still appear to be the best evaluation methods. Often a supervised study plan has met with success.

(*CVL*) The Army Specialized Training Program appears to have reaffirmed the long-held theory that education succeeds best when the total or whole individual is exposed to the process. While higher education in the past has all too often rendered only lip service to "wholism" the recent results of the service programs may serve to stimulate interest in the whole individual.

There is a definite feeling that the heavy academic load required of trainees could not have been carried without the accompanying activity and recreation programs. Physiologists and mental hygienists have indicated this for many years, hence the results noted above were to be expected by those informed.

A strong motivating force made the physical education program very acceptable to the trainee. If the physical education programs after the war are to be successful, strong motivation forces must be stimulated. The physical education instructional staff cannot supply this alone. If the other academic departments and administrative forces do not appreciate the need for health and physical fitness in the student and actively support such a program, best results cannot be obtained.

The hard, strenuous, severe program given the trainee undoubtedly will not continue after the war, and probably it should not. But it is apparent that every publicly supported institution owes society some guarantee and should underwrite the health and physical fitness of its graduates not only from the standpoint of serving their country in time of war but to assure that the education they have acquired may be utilized for the benefit of society for a prolonged period of time.

The work in physical education will differ somewhat from the prewar and war programs, perhaps becoming a combination of the two. The prewar program was largely recreational in nature with little attention to physical fitness; the war program has been the opposite. The postwar program should give attention to both, physical fitness being a prerequisite to a recreation program.

SUMMARY

The opinion seems to prevail that with one exception accomplishments in the Army Specialized Training Program have been constructive. In chemistry the result is doubtful probably because streamlining was too severe. In the engineering programs basic subject matter common to all branches of engineering has been adequate. In the specialized subject matter, some question exists as to achievements in skeletonized courses, particularly in those courses where new subject matter was introduced which had not been previously included in civilian instruction. Engineering instructors believe that trainees who completed the program may be compared to civilian students who on finishing the junior year under a normal program had been exposed to highly specialized subject matter on a streamlined basis.

The conclusion, however, is that considering staff handicaps, irregular schedule patterns, heavy loads, sometimes crowded facilities, and with obvious student handicaps, accomplishments have exceeded expectations. "Certainly," says Dean Gleeson, "the training has provided some continuity of technical instruction throughout the war period which will tend to provide reasonably trained manpower for the immediate future." In other subjects it is believed trainees have obtained basic information of permanent value and that the experience gained by the faculty in handling the entire program will have a constructive influence in civilian teaching to a greater extent than is now recognized.

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NORTHWEST SCIENCE

November, 1945

Vol. XIX, No. 4

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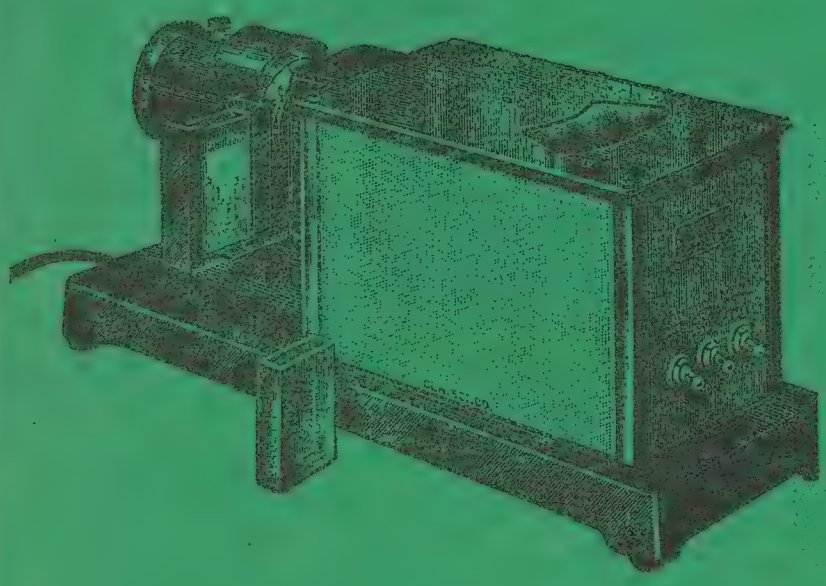

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1945

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty-five cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

NORTHWEST SCIENCE

VOL. XIX, NO.4 NOVEMBER, 1945

Editor, W. R. HATCH, State College of Washington

To the Members of the Northwest Scientific Association:

The Northwest Scientific Association has been relatively inactive during the war except that it has maintained the publication of NORTHWEST SCIENCE during that period. The 18th annual meeting of the Northwest Scientific Association was held in December, 1941. There have been no meetings since. The 19th annual meeting will be held December 27 and 28, 1945, at the Davenport Hotel, Spokane, Washington.

When an organization has been more or less dormant for a period of time it is hard to get it functioning again. The attendance at previous annual meetings of the Northwest Scientific Association has indicated that there are many workers in the field of science in this area who feel the need for a regional scientific association. They are located in the colleges and universities, in the high schools, in many of the industries and professions, as well as in state and governmental agencies. The A. A. A. S. will not have its general meeting until March, 1946. The 19th annual meeting of the Northwest Scientific Association in December will, therefore, offer a unique opportunity for all who are active in or interested in science to get together. If this meeting is to be a success each of you will have to contact scientists who have come to the region since 1941, and acquaint them with the association and invite them to offer papers.

An executive meeting was held in Spokane, October 13, and the following general program for the annual meeting adopted:

Thursday, A. M., December 27

Registration—beginning at 9:00 o'clock.

General meeting—beginning at 10:00, preliminary organization, naming of committees, etc., followed by the principal speaker for the meeting, President Wilson Compton of the State College of Washington.

Thursday, 12:00 Noon—Luncheon, with a speaker of national importance.

Thursday, P. M. will be devoted to meetings of the sections.

Friday morning—Business meetnig of the Association at 9:00 o'clock with the election of officers and reports of officers and committees, followed by the address of the retiring president, J. H. Christ, of the Regional Office of the Soil Conservation Service at Portland.

Friday, P. M.—Section meetings.

While many of the section officers elected at the 1941 meeting have left the region, we now have at least one section officer for each section. If you have a paper to read, please send the title of the paper to the proper section officer, indicating the time needed for its delivery as well as whether or not it will require a lantern, black board, etc. Below is a list of the sections and the officers to whom this information should be sent.

Bacteriology and Public Health:
Chairman: Dr. Ernest McCulloch, State College of Washington, Pullman, Washington.

Botany-Zoology:
Chairman: Dr. Gordon B. Castle, Montana State University, Missoula, Montana.

Chemistry-Physics-Mathematics:
Chairman: Dr. J. L. Culbertson, State College of Washington, Pullman, Washington.

Engineering:
Chairman: James G. McGivern, Gonzaga University, Spokane, Washington.

Forestry:
Chairman: H. T. Gisborne, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.

Geology-Geography:
Chairman: Dr. Julian D. Parksdale, University of Washington, Seattle, Washington.

Social Science:
Chairman: Dr. Lee J. Cronbach, State College of Washington, Pullman, Washington.

Soil Conservation:
Chairman: Dr. C. P. McGrew, 1907 Monroe Street, Pullman, Washington.

We want to get the programs for the annual meeting to you by mid-December. Will you, accordingly, please send the title of your paper to the proper section officer by December 5. He will then send the program for this section to Professor J. W. Hungate by December 10.

During the war period some of us have not paid our annual dues ($1.00 per year). The publication of NORTHWEST SCIENCE has made it necessary to dip into the small savings account of the Association. The executive committee hopes that those of us who are in arrears will volunteer to pay their dues when they register at the annual meeting. Recognizing the need for better financial support for NORTHWEST SCIENCE, the executive committee has also authorized the collection of a special assessment of $1.00 at the annual meeting.

Out-of-town members are urged to make their hotel reservations early.

J. W. Severy, President

PHYSIOGRAPHIC DIVISIONS OF THE COLUMBIA INTERMONTANE PROVINCE

For two successive years a symposium was held by the Geology-Geography section of the Northwest Scientific Association on the physiographic divisions of the so-called "Columbia Plateau." In part as a result of these discussions a paper on the "Physiographic Divisions of the Columbia Intermontane Province" has been published by Otis W. Freeman, J. D. Forrester and R. L. Lupher in the June, 1945, number of the Annals of the Association of American Geographers, pages 53-75. As this publication may not be available to many readers of Northwest Science, one reprint of the article will be sent on request, so long as the supply lasts, by writing Otis W. Freeman, Department of Geology and Geography, Indiana University, Bloomington, Indiana.

THE MIGRATION OF SWAINSON'S AND BROAD-WINGED HAWKS THROUGH COSTA RICA

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Most of the northern birds that migrate to or through Costa Rica pass so inconspicuously that they are not likely to attract the attention of anyone except the enthusiastic bird-watcher, who with his field-glasses painstakingly picks them out amid the dense tropical vegetation. Of the smaller birds, Barn Swallows, Cliff Swallows and Kingbirds migrate by day in flocks large enough to draw the notice of the more observant. But the enormous flocks of big hawks, streaming majestically across the sky, taking at times an hour to pass overhead, are so spectacular that they claim the attention even of the rude peasant, whose interest in Nature is in general limited to those things that can be eaten or turned to profit. Except among the bird islands of Perú, I have never seen aggregations of birds so vast as those formed by the migrating Swainson's Hawks. Perhaps now that the Passenger Pigeon has passed into oblivion, these are the most spectacular mass movements of birds to be seen on the the North American continent. Although the migrating flocks of Broad-winged Hawks form a stirring and memorable sight, they fade into insignificance beside the innumerable hosts of the Swainson's Hawks.

Swainson's Hawk (*Buteo swainsoni*) breeds in Alaska, Canada and the United States, chiefly west of the Mississippi. In winter it spreads over a vast area stretching from South Dakota to Chile, but the majority of individuals are said to pass this season south of the Equator. In Central America, Cherrie (1890) records its occasional presence near San José, Costa Rica, between November 1 and February 25; but it is known chiefly as a bird of passage. The Broad-winged Hawk (*Buteo platypterus*) nests in North America mainly east of the Mississippi, from Canada to the Gulf coast, and winters from the Ohio and Delaware valleys south to Venezuela and Perú. In Central America it has often been recorded as a winter visitant, but is far more abundant as a bird of passage. These two related species, which breed in complementary areas of temperate North America and winter in overlapping parts of South America, mingle together as they pass on migration through the thousand-mile-long isthmus known as Central America.

During nine of the ten years when I have been in Costa Rica in March and April, I have watched one or the other, and often both, of these hawks pass northward in their thousands. Only during the year when I dwelt near Vara Blanca did I fail to notice them. A consideration of the topography of the country makes it seem unlikely that they should habitually pass this point on the northern slope of the Cordillera Central, an east-and-west range that forms a barrier they need not cross. Until 1940, I failed to distinguish Swainson's Hawks from the Broad-wing, to which alone I had been able to come sufficiently close for positive identification. My earlier notes refer to all of these big hawks that migrate in flocks as Broad-wings; but from subsequent observations, I feel confident that the most spectacular flocks that I had witnessed were made up chiefly of Swainson's Hawks, with perhaps an admixture of Broad-wings. These two species migrate as a rule in separate flocks; but at times a few individuals of one kind may join a flock of the other kind, forming usually a small minority. When they fly together at a moderate height, Swainson's Hawk may readily be distinguished from the Broad-wing by the considerably greater spread of wing of the former. Under favorable conditions of illumination, the Broad-wing may be recognized by the three, broad, whitish bands across its blackish tail. The

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dark bars on the tail of Swainson's Hawk are more numerous, more narrow, and contrast less strongly with the ground color, hence are difficult to distinguish when the bird flies high overhead.

Aside from the striking difference in the size of the flocks, these two hawks migrate in much the same maner. They try to obtain the maximum of forward movement with a minimum of muscular exertion. They journey only during the daytime, while conditions are favorable for soaring flight, and seem reluctant to make a single unnecessary wing-beat. Since they appear to fast while on migration, it will be appreciated that the saving of energy is of the utmost importance to them. Repeated personal observations, together with the experiences of other residents of the country, have convinced me that the great majority of these hawks pass without eating, and I believe also without drinking. Exceptional individuals that are sickly or in poor physical condition may be obliged to fall out of the ranks and take refreshment.

As they migrate, the big hawks regularly alternate between two distinct modes of flight, each accomplished with the wings and tail held in a characteristic manner. First they soar upward to gain altitude, then they glide forward on their way, at the same time generally losing altitude, trading it, so to speak, for forward movement. The soaring to gain altitude is generally performed above some ridge, especially one facing the sun, where there is an updraft of air. With wings spread to the fullest, the tips of the primary feathers well separated so that sky may be seen between them, and the tail half-spread, the hawks gyrate round and round, gradually spiralling upward as the ascending current lifts them with no expenditure of energy of their own. At times all the hawks in the same great vortex will rotate in the same direction—a beautiful spectacle!—but perhaps more often there is no set direction, some individuals circling in a clockwise maner, others in the reverse direction.

When they have ganied sufficient height above the earth, the hawks leave the vortex. Now closing their wings until the forward margin is strongly convex and the joined tips of the primaries are directed backward in a single sharp point, completely folding the tail, they glide easily forward on their way across the sky, until they find another ascending air current, generally above another ridge, where they pause and circle once more to regain their lost altitude. The hawks are sometimes said to travel in circles, but such a description of their flight shows a misapprehension of its nature. They rotate to gain altitude, not to move forward; and only with an exceptionally favorable combination of air currents could they do both at the same time.

From some high point which commands a wide prospect over hill and vale, the passage of the hawks presents an unforgettable sight. Streaming in a long column across the valley, the birds double back on their course to form a vortex above the crest of the ridge. Around and around they circle, the whirlpool of birds growing taller and denser as the first comers rise higher, and their place at the bottom of the vortex is filled by later arrivals. Then, at the top, the foremost birds straighten their course and glide in open ranks across the next valley. The vortex of birds may remain for many minutes in approximately the same position, or it may gradually drift along the ridge; its composition is constantly changing as some individuals sail out at the top while others enter at the bottom. Often the migratory host of Swainson's Hawks will stretch right across the sky from side to side, the birds continuing to stream by with scarcely a gap in their ranks for about an hour. After a short intermission, a second flock may follow the course of the first.

Some of the migrating hawks of both species, and in both adult and immature plumage, are still moulting. As they pass overhead in March and April, gaps left by fallen feathers in their wings or tails stand out closely against the sky.

It has been my good fortune to watch the hawks as they settle to rest at the

end of a long day's flight, while the sun sinks low, as they depart when the rising sun warms the air, and as they pass high overhead during the middle hours of the day. Nearly all of these observations were made in the basin of El General, which is the name applied to the upper part of the Tèrrabà Valley, in the Pacific drainage of southern Costa Rica. Here, because of the curvature in the backbone of the continent, the direction of the mountain ranges, the coastline, and the principal rivers, is such that the hawks on their northward journey actually travel in a westerly course, up the valley between the high cordillera on the north and the far lower coastal range on the south. One year, when I dwelt in a cabin facing the Río Pacuar, at the very head of the Tèrraba Valley, a great flock, containing countless thousands of Swainson's Hawks, stopped for the night on the opposite side of the river. My journal of the period contains an account of this memorable event, written just after the hawks had passed.

"April 15, 1940. This afternoon, at about four o'clock, I looked up from my writing and noticed a number of large hawks settling down upon the hillside across the Río Pacuar. At the first glimpse, I thought they were vultures flocking down to feast upon some animal that had died in the pasture; but looking more closely, I perceived that these birds were too light in color to be vultures, and far too numerous. A great host of migrating Swainson's Hawks, such as I have frequently seen floating across the basin of El General, was soaring over the forested crest of the high ridge to our east, and from this the birds were slowly circling downward to the hillside. A great number came to rest upon the close-cropped hillside pasture, where, turning outward their white under plumage, they were conspicuous from afar. Others found perches on the trees at the edge of the forest, or growing scattered through the pasture, or along the banks of the river, much to the annoyance of the small birds now building their nests there. The flycatchers were particularly resentful, and darted angrily at the intruders. It required about an hour for the huge multitude of birds to drop easily and sedately out of the air. In addition to those that came to rest on our side of the ridge, hundreds or thousands more settled out of sight beyond it.

"The hawks on the open hillside spaced themselves well apart, each as a rule several feet from its neighbors. There was no crowding or bunching; they did not seem to be of very sociable dispositions, despite their vast aggregation. Those in the trees, too, kept a little aloof from each other; although there were often several in one tree, they perched in different parts of it. When I went out to examine them with my binoculars, I found considerable individual variation in their temper. Some took flight while I was still a good distance away, while others permitted a very satisfactorily close approach. All were perfectly silent.

"In this great flock composed entirely of Swainson's Hawks, there was an amazing diversity in plumage, caused in part by age and sex, in part by the two color phases whcih occur in this species. Those which I tok to be adult males in normal plumage were the most handsome, and displayed the greatest areas of pure white on the underparts. They had the sides of the neck and chest heavily marked with rusty brown, and a few flecks of this color across the center of the chest, forming a broken necklace. Other individuals were variously marked with dull brown on the under parts, those in the 'melanistic' color phase so thickly that little white was displayed. But all, old and young, normal and melanistic, showed a whitish area at the base of the tail above, (never so prominent as on the Marsh Hawk), which is a good recognition mark for Swainson's Hawk.

"As the day closed, there was a certain amount of shifting of positions among the resting hawks. Some which had been standing on the ground flew up into the trees, or to another part of the hillside. But while the light faded many remained on the ground, to all appearances content to pass the night there. Others rested on low stumps and

logs scattered about the pasture. But the majority of those in sight perched in the trees.

"April 16. As day broke, some of the hawks flew down from the edge of the forest to the pasture. They lingered on their slope facing the west until the rays of the rising sun fell upon the crest of the tall trees of a little patch of forest on the brow of the opposite hill, across the Río Pacuar. When they noticed these tree-tops in the sunshine, the hawks began to fly across to them, alternately flapping and gliding, streaming across one or a few at a time rather than as a group. Soon these tree-tops were full of them; but the birds were well distributed over the wide-spreading boughs and did not crowd. I did not notice until later that a great many more had settled on the ground in the open pasture on this same eastern slope, where they enjoyed the earliest sunbeams. Soon the western slope where they had slept, still in shadow, was abandoned by them.

"Here in the sunshine they lingered for well over an hour. They remained perfectly silent, and made as little attempt to find breakfast as they had made to find supper the evening before. They made their long journey on an empty stomach. At half-past seven they began to bestir themselves, with a little flapping of wings they set themselves in motion; but they had hardly risen above the lower of the scattered trees on the hillside when they ceased to exert themselves and began to soar around and around, rising slowly in spirals on the ascending currents of air formed on this open slope heated by the rising sun. As soon as they had begun to be lifted up by the air currents, they ceased to flap their wings. Since they take no nourishment on their journey, the conservation of their vital forces is of great importance to them.

"As soon as they had gained an altitude of a few hundred feet, the hawks detached themselves from the top of the column of circling birds and glided off away from the sun, still without flapping their wings. By now those hawks which had passed the night beyond the high forested ridge on the other side of the Pacuar had begun to glide across the valley in a steady stream, above those of their kind rising from the hillside which I watched. Above a long slope farther to the west, the birds of this second group delayed their forward progress to spiral up to greater heights, preparatory to crossing the forested summits that rose ahead of them. Here they were joined by the birds which had taken the air on the hillside that I was watching. The two groups mingled and formed one great vortex of circling hawks. From the apex of this feathered whirlpool, they glided off to form still loftier spiring columns over the higher slopes beyond. While the migrating swallows prefer to travel up the valley, in a northwesterly direction, the hawks chose to journey above the low mountains of the coastal range south of the river, taking a more westerly course. Doubtless this is because the more broken mountainous terrain is more prolific of the ascending currernts of air essential to lift them up without physical exertion on their part. The swallows, feeding as they travel, propel themselves by wing-motion and neither soar nor glide.

"Before long the vanguard was shrinking to the vanishing point above the distant forested summits. Here and there in the intermediate space were ascending columns of hawks, which were constantly detaching themselves from the summit to stream across to the next vortex to the west. Before me on the grassy hillside were many birds just beginning to spiral up above the tree-tops, others flapping out to join them, with many more still resting motionless whlie they watched their comrades depart. To the east were two circling clouds of hawks just beginning to rise up above the high ridge where they had passed the night, with a steady stream of them gliding overhead as they crossed the valley. It was fascinating to watch so many great birds in various stages of preparation for their long, effortless journey. Barn Swallows and a few Bank Swallows wheeled above me in the open valley where I stood, having evidently decided to halt and eat rather than travel this day.

"It required a full hour for the vast multitude of hawks to take the air; and early risers—in a very literal sense—had long since vanished into the intense blue of this brilliant morning when, at 8:30, the last two sluggards bestirred themselves for the journey. As one of the these alternately flapped and soared above a thatched hut standing solitary near the foot of the hill, a Lichtenstein's Kingbird pursued and buffeted it angrily, as though venting his whole spite against this vast predatory horse upon its last representative. But the valiant little kingbird hardly caused the great hawk to accelerate its pace; it flapped around until the air caught it and it could soar, then soon rose to heights where the kingbird did not care to follow. Although these two were the last from the near hillside, it was not necessary for them to travel alone. A few others were still soaring by from the eastern ridge, while far away in the southeast were great circling swarms that had rested, apparently, among the distant hills. All these had passed from sight when, at 9:30, a single hawk swept down from the forest on the ridge and vanished flying low above the pastures. Evidently it was not feeling fit for the journey, and had decided to pause for a day's hunting.

"When the hawks had vanished into the west, I went to examine the hillside upon which so many had rested the previous afternoon and night. I had read (Dickey and Van Rossem, 1938) that while passing through El Salvador on their northward migration, Swainson's Hawks rest on the lava fields of some of the volcanos, and at times leave eggs behind. I hoped to find an egg or two, and I wished also to search for droppings and castings, as evidence of whether the hawks do or do not take food while they migrate through Central America. The white dropping of so large a hawk would have been conspicuous on the close-cropped grass of the hillside pasture; but I searched over most of the ground without finding a single one, nor any casting, nor any egg. They had passed by without leaving so much as a moulted feather as a memento of their passage.

"I think it evident that these hawks, like the Broad-wings, soar through Central America without hunting. Had that great host attacked the local population of birds or rodents yesterday afternoon, they must have sadly depleted their number. But they passed on, leaving our local birds as numerous and as noisy as before. A boy who was watching the hawks yesterday afternoon opined that they came from 'The Coast"—when the coast is the most distant region of which one has even a vague, imaginative conception, it is the home of all mysteries. But it takes vaster coasts than those of this little country to support such myriads of big predatory birds. They must spread over wide continental areas to seek their sustenance. The great majority, if not all, of these migrants must winter over the immense areas of South America; doubtless they will not break their fast until they have passed somewhere to the north of the Isthmus of Tehuantepec. Central America is too small for them."

The house in which I have dwelt for the past four years is well situated for watching the migrations of the hawks. It stands upon a high, narrow terrace, facing the rising sun and the Peña Blanca River, a tributary of the Rio Térraba flowing down from the lofty summits of Chirripó, the highest peak in the country. Behind the house, to the west, rises a steep hillside pasture, which, when warmed by the early morning sunshine, provides ascending currents which the birds utilize to gain the altitude they need for beginning their day's journey. Across the river to the east is a long ridge with a wooded summit. These north-and-south ridges run athwart the hawks' line of flight, and so provide a terrain rich in the air currents that help them on their way.

On March 23, 1943, three flocks of hawks passed within view. In the middle of the morning a small flock of Broad-wings soared overhead, as usual traveling westward. In the middle of the afternoon, while the sky was still darkly overcast and threatening after a heavy shower, a much larger flock, apparently Swainson's Hawks,

spiralled upward above the valley to the north. Then, later in the afternoon, I watched a third flock, afterward found to be composed wholly of Broad-wings, drifting down nito the forest on the ridge across the Peña Blanca to the east. With spread motionless wings and much circling, they glided slowly downward to alight in the tops of the tall forest trees. About thirty settled in the nearly leafless, spreading crown of a giant tree that towered above its neighbors, while others came to rest amid the surrounding foliage. It was then 5:20 P. M., and the light was already growing dim beneath a heavily clouded sky. I had supposed that the hawks in the leafless tree would remain there for the night; but before it grew dark they moved away, apparently to the neighboring leafy crowns where they were screened from my view.

The great tree in which the hawks had perched was clearly visible, at a distance of half a mile or so, from the front windows of the house; and the following morning at daybreak I began to keep watch over this part of the forest. But I saw not a sign of the howks until 7:30, 1¾ hours after sunrise. Then a few appeared, flying above the tree-tops on the distant ridge. Some flew along the ridge to the south; others came down the steep slope toward the west, crossing the river to my side. I hurried down through the farm in time to see them circle and rise above the high bank at the edge of the terrace. When they had gained a little altitude here, they moved across a level field to the slope that rises to the long forested ridge, and here spiralled higher into the clear morning air. Others of the flock began to rise upward on the farther side of the ridge where they had apparently roosted, but these also soon glided across the river to take advantage of the ascending currents above the east-facing bushy slopes, where the previous year grain had been sown. But the updrifting currents were still weak; the birds rose slowly, and the last needed to flap their wings a good deal to keep up with their companions. The laggards vanished over the tree-tops, travelling westward, at about 8:15. I distinguished only Broad-wings in this flock, which contained less than one hundred birds.

Here again there was no indication that the hawks sought food either in the evening or in the morning before departing. They could hardly have hunted with success without spreading over the countrysdie and dispersing the flock in which they travelled. In Chile, Darwin (1860) was told that the Condor may go without food for five or six weeks, without loss of vigor. Some individuals kept in captivity were fed only at weekly intervals, and appeared to be in good health. Since these hawks migrate with so little muscular exertion, it is probable that they can continue for a week or two without eating.

Aside from these two flocks, the first of Swainson's Hawks and the second of Broad-wings, I have not discovered the locations in which the migrating flocks passed the night. But many other times I have watched the hawks, chiefly Broad-wings, rise up from a low altitude above the sun-facing terrace in front of my house and the hillside pasture behind. These birds seemed to have roosted not far off and to be just starting off on their day's journey. The earliest hour at which I have seen the hawks rising to begin their journey was 7:30 A. M., and even this early only when I have had their roosting place actually in view. More often I have seen them around eight o'clock. Hence it is evident that they do not set out until the sun has risen and its radiant heat has begun to create rising currents to lift them into the air. But swallows, which travel by beating their wings rather by gliding, and are to the hawks as motorboats to sailships, often begin their day's migration at six o'clock, just as the sun is rising.

Later in the day, the hawks usually pass overhead at heights far greater than those at which one sees them in the early morning; although if the sky is overcast and atmospheric conditions unfavorable for soaring, they may pass at low elevations even in the middle of the day, pausing to take advantage of every slightest updraft they can find beneath the lowering sky. At midday in fair

weather, the hawks are likely to pass unnoticed because of the great height at which they travel; I have far fewer records of them at such times than for the early forenoon and for the middle hours of cloudy days. Between four and five o'clock in the afternoon they seem usually to end their journey, and go supperless to roost. It is the interest in this connection that Broun (1935), who observed the fall migration of seventeen kinds of birds of prey along the Kittatinny Ridge in Pennsylvania, found that in favorable weather the first birds flew by the lookout promontories by 7:30 or 8 o'clock. An hour later the flight was well under way. The greatest numbers of hawks usually passed during the forenoon, and again from 2 to 4:30 o'clock in the afternoon, at which hour they could be seen settling down for the night. He thinks it likely that during the midday lull in the migration the hawks delay their journey while they feed and rest. I have never seen anything to suggest that Swainson's and Broad-winged Hawks rest at midday while passing through Costa Rica; and as to feeding, it is inconceivable that the thousands of birds in a flock of Swainson's Hawks could find food without dispersing so widely that it would take them hours to re-assemble.

Some of the flocks of Swainson's Hawks are so unbelievably vast that the watcher receives the impression that practically the whole of the species must be represented in that one immense aggregation of migrating birds. Thus Griscom (1932) writes: "Apparently the great majority of the individuals in existence pass over Central America in a comparatively few days in a few enormous flocks, which take hours to pass a given point." An examination of the dates on which the hawks were seen to pass will throw light upon this aspect of the migration. We shall consider the two migrant species separately.

In 1936, I saw a single immense flock, apparently of Swainson's Hawks but too high for positive identification, which flew from east to west above the Río Buena Vista (a tributary of the Térraba River) on the morning of April 12, taking over an hour to pass. It was wonderfully impressive to watch the big birds flow endlessly over the lofty eastern ridge, stream in countless thousands high above the profound valley, gather into an immense ascending whirlpool above the barrier on the farther side, then drift away above the wild mountains to the west. The following year, in the same locality, I recorded also a single vast flock, which passed on precisely the same date, April 12. In 1940, beside the Río Pacuar at the head of the Térraba Valley, I saw two great flocks, apparently of Swainson's Hawks, pass northwestward on April 14, the first at 10:15 A. M. and the second at 4 P. M. Then, the following day, there arrived the stupendous flock, part of which spent the night on the hillside opposite my cabin, and whose behavior has already been described. This was the first time that I came close enough to Swainson's Hawks for positive identification. My reason for including the other of the foregoing records as of this species is that, whenever identification has been possible, the great flocks containing thousands of individuals have always proved to be composed mainly or wholly of Swainson's Hawks. Whenever it could be clearly seen that Broadwings were in the majority, the flock has consisted merely of a few score or at most a few hundred birls. But, as already stated, a few individuals of each species, probably stragglers from the main contingent of their kind, may at times be seen in aggregations of the other species.

In 1941, a big flock of Swainson's Hawks, readily identified, passed at a low elevation down the valley of the Río Pejivalle, travelling toward the northeast, early on the afternoon of April 11. The following morning another multitudinous flock followed the same course. Since the Río Pejivalle is on the Caribbean slope of Costa Rica, separated from El General by a range of mountains 10,000 to 12,000 feet in height, it is evident that on their northward migration Swainson's Hawks pass through the country on both sides of the Cordillera.

During the following years I was at

my present locality beside the Río Peña Blanca in the district of El General called Quizarrá, at an altitude of 2500 feet above sea-level. Here, because of unusually favorable conditions for observation, the hawks often passing at no great height, I have been able to make many positive identifications of both species. In 1942, I had relatively little time for bird-watching, and did not record Swainson's Hawk. In 1943, large flocks of Swainson's Hawks passed on March 9, March 22 and April 4. Another flock that went by on March 14 was possibly of this species. In 1944, a huge flock of Swainson's Hawks passed westward on March 12, smaller flocks, containing merely 'hundreds' of birds, went by on March 13 and April 9. On March 10, three great flocks, each containing 'thousands' of birds, doubtless of this species, passed too high for identification; another big flock sailed overhead at a great height at 2 P. M. on March 16. In 1945, when the dry season during the early months of the year was devastatingly severe, the migrating hosts of Swainson's Hawks seemed to be more broken and scattered than in other years. The first to be seen passed in a small flock on March 22. Other small flocks of this species, or individuals travelling in small parties of Broad-winged Hawks, were recorded on April 7, 8, 15, 19, 20 and 22. The only large flock was seen on April 16. This was estimated to contain thousands of birds, and took about twenty minutes to stream over the small opening in the forest where I chanced to be at the time. Perhaps many more crossed neighboring portions of the ridge, where the trees screened them from my view.

It is evident that to obtain a complete picture of the migration of Swainson's Hawks through Costa Rica would require the efforts of coöperating observers scattered over a broad front. Unfortunately, so far as I know, I am the only active bird-watcher at present resident in the country. However, a few general conclusions may be drawn from the data presented in the foregoing paragraphs. Although in some years, as 1936, 1937 and 1940, I saw the Swainson's Hawks pass in one or two flocks so huge that it was easy to believe that they contained the bulk of the migratory population of the species, there is no reason to suppose that every northward-bound party of these hawks passed within view of the narrow district where I worked, or even that I saw all of those which passed; for much of the time I was in the forest with a closed canopy of leaves above me. Subsequent observations showed that they travel through Costa Rica on both sides of the Cordillera, that they may pass in successive flocks over a period of about a month, and that in some years (as in 1945) they may be seen at the same locality on as many as eight days. Actually, they probably flew over this point on additional days when the observer was busy with other pursuits and failed to see them. Extreme dates of their passage through southern Costa Rica are March 9 (1943) and April 22 (1945). In the Museo Nacional de Costa Rica there is a juvenile female Swainson's Hawk labelled "San José, May 3, 1892," and two males and three females, all juveniles, collected at the same locality on the following day.

With the Broad-winged Hawk the picture is much the same, except that this species travels in far smaller flocks, and the situation is complicated by the presence of numerous individuals that winter in Central America. In 1936, Broad-wings passed over the Río Buena Vista on April 6. In 1937, they were not positively identified in the same locality. In 1939, flocks apparently of this species were seen near San Isidro del General on April 13 and May 4. In 1940, small flocks, probably of Broad-wings, were noticed along the Rio Pacuar on March 21 and 27. In 1942, they passed over the Río Peña Blanca on March 16. In 1943, they were definitely identified in this locality in two small flocks on March 22, and a few were seen in a big flock of Swainson's Hawks on April 4. Flocks of hawks seen on March 14 and April 1 of this year were probably Broad-wings. For 1944 there are numerous records. Broad-winged Hawks were first seen migrating in a flock of Swainson's on March 12, and again in the same manner on the following day. A company

of about 40 passed at 7:35 A. M. on March 14; two individuals were seen on March 15; a flock of about 40 flew by at eight o'clock an March 16; a lone bird was recorded on March 19; a flock of about 70 came past at about 9:30 on March 22; 7 or 8 individuals passed over the house on March 24; the last bird to be seen passed solitary on April 1. In 1945, Broad-winged Hawks were recorded on migration on March 15, 18, 22 and 24, and on April 7, 8, 20 and 22. Thus in 1944 Broad-wings were recorded on 9 days; in 1945 on 8. Extreme dates for their passage through southern Costa Rica are March 12 (1944) and May 4 (1939). In both 1944 and 1945 numerous records were obtained. In these two years the date of the beginning of migration varied by only 3 days, but that of the end of migration by 21 days. Cherrie (1892) found this hawk at San José as late as May 1.

During six years I have passed the fall months in Costa Rica, in four of these years in El General, where the spring migration of these two species of hawks is so conspicuous a phenomenon, but I have never seen a single individual of either kind travelling southward. Worth (1939) reports that Señor Mönniche, whose coffee plantation in the El Volcán region of Panamá he visited, was familiar with Swainson's Hawk as a regular spring transient, passing northward in thousands "during about a week of each spring." He had shot from one of these flocks specimens which Worth identified. But he had never once beheld the return migration in the fall. Señor Mönniche's plantation near Boquete, like my own farm in El General, is on the Pacific side of the Cordillera, his experience in Panamá corroborates my own in Costa Rica; and we have the independent testimony of two observers of the failure of Swainson's Hawks to pass southward along the Pacific slope of the Cordillera of southern Costa Rica and adjacent Panamá.

Are we to gather from this that Swainson's Hawks are produced in great numbers 'somewhere in South America,' pass northward in huge flocks each spring, and never return to the southern continent? Such an assumption runs counter to all that is known about the breeding range of the species. And there is ample evidence for their return migration in the fall. But apparently, as with a number of warblers and other birds, their spring and fall journeys follow different routes, at least in part. While visiting the Pacific slope of Guatemala a decade ago, I was told more than once of enormous flocks of hawks that pass southward during the autumn months; but I did not have the good luck to see them. A. W. Anthony, in field notes published by Griscom (1932), mentions a great flock of hawks, apparently Swainson's, which on the morning of October 25, 1925, flew southward over the Guatemalan coffee plantation where he was collecting, taking some three hours to go by. He did not himself witness the flight, having been beneath the shade trees of the coffee plantation when it occured, but was told about it when he returned to the house at noon. No definite locality is mentioned in the text where this information is given; but from reference to Mr. Anthony's collecting itinerary, it appears that on this date he was at the Finca Carolina, in the Department of San Marcos, ten miles south of Tumbador on the Pacific slope.

In Costa Rica, Carriker (1910) mentions an enormous flock of hawks, apparently Swainson's, but soaring at too great a height to be identified, which during the early autumn of 1906 passed from northwest to southeast over El Hogar, in the Caribbean lowlands. In the Museo Nacional of Costa Rica, there is an adult male Swainson's Hawk collected at or near San José on November 25, 1889, when it was probably migrating southward. Hence is appears that Swainson's Hawks migrate in autumn down the Pacific coast of northern Central America through Guatemala and doubtless also El Salvador, Honduras and Nicaragua. Then they appear to cross over to the Caribbean side, probably over the belt of lowlands that traverses the isthmus in southern Nicaragua and northern Costa Rica. A few might continue through Guanacaste and cross the continent along the line of the

Costa Rican railroad, where the continental divide is only 5000 feet high—far lower than through most of southern Costa Rica. This would account for their presence at San José in the fall. Through southern Costa Rica and western Panamá, the hawks would pass entirely to the east and north of the Cordillera. That, at least, is the theory suggested by the scanty information at present available; but many more observations will be needed to firmly establish it.

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TERTIARY CONIFEROUS WOODS OF WESTERN NORTH AMERICA

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(Continued from the August issue)

PREVIOUSLY DESCRIBED WOODS REFERABLE TO MODERN GENERA

According to Krausel:

1. *Piceoxylon pseudotsugae* Gothan, (*Pseudotsuga taxifolia*) by Gothan, California, 1905.
2. *Sequoia langsdorfii* (Brngn.) Heer, (*Sequoia sempervirens*)by Penhallow, various localities, 1907 (and earlier)—in part only.
3. *Taxodium distichum* (Linne) R., (*Sequoia sempervirens*) by Penhallow, various localities, 1907 (and earlier)—in part?
4. *Cupressionoxylon taxodioides* Conwentz, (*Sequoia sempervirens*) by Platen, 1908, Calistoga, California.*
5. *Pityoxylon vateri* Platen, (*Pinus* cf. *insignis* by Platen, 1908, Calistoga, California.
6. *Taxodioxylon credneri* Platen, (*Sequoia sempervirens*) by Platen, 1908, Nevada.
7. *Pinus columbiana* Penhallow, (hard ? pine) by Penhallow, 1912, Midway, British Columbia.

Several well-established generic types have been added since Krausel's report of 1919:

8. *Pinus baumani* Read, (hard ? pine) by Read, 1930, Specimen Ridge, Yellowstone National Park.
9. *Pinus fallax* (Felix) Read, (hard ? pine) by Felix, 1896, Yellowstone National Park; by Read, 1930, same locality.
10. *Cupressus* sp. Webber, (California cypress) by Webber, 1933, Last Chance Gulch, Mojave, California.
11. *Pinus kelloggi* Webber, (soft pine) by Webber, 1933, Last Chance

*Platen, Paul. Untersuchungen fossiler Hölzer aus dem Westen der Verteinigten Staaten von Nordamerika. Leipsig, 1908.

Gulch, Mojave, California.

12. *Cedrus penhallowii* (Jeffrey) Barghoorn and Bailey (cedar of Lebanon) by Jeffrey, 1904, Blue Gap, Sierras, California; by Barghoorn and Bailey, 1938, Auriferous Gravels, California.

LIST OF TYPES[1]

Glyptostrobus europeaus (Brongniart) Heer 1088
Sequoia langsdorfii (Brongniart) Heer 1257
Taxodium dubium (Sternberg) Heer 96

Taxodioxylon Felix
Callitris sp. 1618
Chamaecyparis (?) sp. 1540
Thujoxylon Unger

Thujoxylon spp. 1601, 1917
Cupressinoxylon Goeppert
Cupressinoxylon 2105
C. pearsalli (Andrews) Beck 1217,1231

Larix sp. 2162
Picea sp. 164
Pseudotsuga pseudotsugae (Gothan) Beck 1726
Piceoxylon Gothan
Piceoxylon spp. 952,1341

Pinus kelloggi Webber 1817
Pinus spp. 688,1196,1382 1390,1567,2136
Pityoxylon Kraus

Abies sp.....1114
Cedrus penhallowii (Jeffrey) Barhoorn and Bailey 1366
Keteleeria sp. 1129,1133
Pseudolarix (?) sp. 757
Tsuga sp. 2100
Cedroxylon Kraus
Cedroxylon spp. 1130,1139

Spiropitys Goeppert
Spiropitys (?) spp. 1598,2033
Taxus sp. 853
Torreya sp. 625
Taxoxylon Kraus

[1] Numbers refer to type specimens in catalog of G. F. Beck.

TABLE OF DISTRIBUTION

(Read up for relation of genera to form-genera)

1	2	3	4	5	6	7	Genera	8	9	10	11	12	13	14
			X				Glyptostrobus							
X		X	X	X	X	X	Sequoia		X	X	X		X	X
			X				Taxodium							
(?)			X	(?)	X	X	Taxodioxylon Felix		(?)	X	X			X
			X				Callitris							
		X					Chamaecyparis (?)							
	X						Cupressus						?H	
							Libocedrus (Bailey)						X	
	X		X				Thuyoxylon Unger							
X		X	X	X	X	X	Cupressinoxylon Goeppert		X	X	X	X	X	X
			(?)				Larix			X				
			X				Picea							
			X	(?)		X	Pseudotsuga						X	
X		X	X			X	Piceoxylon Gothan				X			X
X	X		X	X		X	Pinus			X	X	X	H	X
					X	X	Pityoxylon Kraus						H	X
		X	X				Abies			X				
							Cedrus	X		H	X			X
				X			Keteleeria	X			X		?H	X
		X					Pseudolarix (?)							X
		X					Tsuga							
						X	Cedroxylon Kraus	X			X			X
							Spiropitys Goeppert			(?)	(?)			
			X				Taxus							
			X				Torreya							
							Taxoxylon Unger							
			X				Ginkgo (ales)							
							Coniferoxylon Cramer							X

(?) means identification in question.
(H) means locality and horizon in question.

TABLE OF DIAGNOSTIC FEATURES

Generic Types		Resin Canals: Vertical: Normal	Resin Canals: Vertical: Traumatic	Resin Canals: Horizontal	Rays: Uniseriate	Rays: Height (max.)	Pitting: Trach-eid.: Number	Pitting: Trach-eid.: Position	Pitting: Ray: Field	Pitting: Ray: Walls	Miscellaneous: Parenchyma	Miscellaneous: Ray Trachieds	Miscellaneous: Spiral Thickenings	Miscellaneous: Textue
		1	2	3	4	5	6	7	8	9	10	11	12	13
1. Glyptostrobus	1088				X	M	M	O	B	(?)	D			70
2. Sequoia	1257		X		X	H	M	O	U	I	D			90
3. Taxodium	96				X	H	M	O	U	I	D			90
4. Callitris	1618				X	L		O	(?)	(?)	D			50
5. Chamaecyparis(?)	1540				X	M		O	U	N	D	X		50
6. Thuyoxylon	1601				X	L		O	U	(?)	D			50
7.	1917				X	L		O	U	(?)	D			30
8.Cupressinoxylon eutreron	2105				X	M		O	U	(?)	D			60
9.....	1231													
pearsalli	1317				X	M		O	U	N	D			100
10. Larix	2162	F	X	X		M		O	B	A	T	X		90
11. Picea	164	F	X	X		H		O	U	A		X		90
12. Pseudotsuga	1726	F	X	X		H		O	U	A	T?	X	E	90
13. Piceoxylon	952	F	(?)	L		M		(?)	(?)	(?)		(?)		70
14.	1341	F	X	X		M		O	(?)	A		X		80
15. Pinus kelloggi	1817	S		X		M		O	B	A		N		40
16. Pinus spp.	688,1196, 1382,1390,1567,2136	S		X		M		O	V	V		V		V
17. Abies	1114		X		X	M		A	(?)	A				90
18. Cedrus	1366		X	L		H		A	U	A				25
19. Keteleeria	1129	F	X		X	M	M	A	(?)	A				90
	1733													
20. Pseudolarix (?)	757		X		X	M		(?)	(?)	A	T	S		50
21. Tsuga	2100		X		X	M		(?)	(?)	A	T			50
22. Cedroxylon	1130				X	H	M	A	(?)	A				100
23.	1139				X	M		A	(?)	A				60
24. Spiropitys (?)	1598				X	M		O	(?)	N	(?)		X	40
25. ..... (?)	2033				X	H		O	(?)	(?)	X		(?)	50
26. Taxus	853				X	L		O	U	(?)			X	40
27. Torreya	623				X	M		O	(?)	(?)			P	80
28. Ginkgo	756				X	L		O	(?)	I				70
	805													
29. Coniferoxylon krausei	766		X	L		M		O	(?)	I	D			70

Ginkoales
Ginkgo adiantoides (Unger) Heer 756,805

Coniferoxylon Cramer
Coniferoxylon krausei (Felix) Beck 766

LOCAL DISTRIBUTION OF THE KNOWN TERTIARY CONIFEROUS WOODS

Localities in the Order of Their Presumed Age

1. Calistoga, California, Pliocene.
2. Mojave California, in particular Last Chance Gulch, Pliocene.
3. Rainbow Ridge, and Virgin Valley, northwest Nevada, Pliocene (?).
4. Russell Forest Series, associated with the Columbia (Yakima) Basalts of central Washington, Upper Miocene.*
5. Blue Mountain Fringe, Burns and Pendleton, Oregon and Cavendish, Idaho, probably associated with the Columbia Basalts, Miocene (?).
7. Miscellaneous late Tertiary localities.

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*For distribution of the conifers within the Russell series of forests as well as for their association with abundant hardwoods, see the author's "Ancient Forest Trees of the Sagebrush Area in Central Washington," Journ. of Forestry, 43-334-338. May, 1945.

8. Bonneville, Oregon and Washington, Eagle Creek Formation, Oligocene (?).
9. John Day Formation, Oregon, Oligo-Miocene.
10. Sweethome and Eugene region, Upper Willamette Valley, Oregon, Oligocene (?).
11. Cowlitz Formation and derived woods, Chehalis region, Washington, Eocene.
12. Yellowstone National Park region, Iocene.
13. Central Sierra region including possible derivative woods at Dublin and Antioch, California, Eocene (?).
14. Miscellaneous early Tertiary woods or general Tertiary.

KEY TO GENERA

(Numerals Refer to Illustrations)

1. Abietineous pitting (26,27), and/or resin canals (2-10) — Cedroxylon, Pityoxylon .....2.

1. Abietineous pitting wanting, no resin canals excepting traumatic rows occasionally in *Sequoia* (11) — Cupressinoxylon, Taxoxylon, Ginkgo .....3.

2. Vertical resin canals scattering (3,19), festooned (4-7), or in traumatic rows (4), horizontal canals always present (5,20,21), tracheid pitting opposite (to clustered) (30) — Pityoxylon ..... 6.

2. Vertical resin canals in traumatic rows only (8-10) save in *Keteleeria* where they also occur festooned (7), horizontal (large) canals only in *Cedrus* 8, cf. 21), tracheid pitting occasionally alternate (32) — Cedroxylon .....9.

3. Tracheid cells rounded and variable in diameter (1), no normal parenchyma but occasional crystalliferous strands (24,28), rays low (24) — *Ginkgo.*

3. Tracheids mostly regular in shape and size (17), parenchyma present (11-16) or wanting (17-18), ray height variable, sometimes very high (*Spiropitys*) .....4.

4. Spiral thickenings wanting, parenchyma present and usually conspicious. (11-16) — Cupressinoxylon .....13.

4. Spiral thickenings present (cf.30), parenchyma wanting (17-18), or present in Spiropitys — Taxoxylon .....19.

5. Anomalous woods with combinations not listed above—here in *C. krausei* (a) traumatic canal rows, (b) parenchyma diffuse, (c) large (and small) horizontal canals normally scattering — Coniferoxylon.

PITYOXYLON

6. Resin canals equidimentional and rounded (3), usually surrounded by an irregular zone of broken down epithelial cells, (19), canals scattering (3,19), sometimes in pairs but not in festoons or traumatic rows — *Pinus.*

6. Resin canals variable in diameter and tending to be oval in shape (4), surrounded by thick-walled cells, typically festooned (4-6), and occasionally in traumatic rows — Piceoxylon ..... 7.

7. Spiral thickenings upon even early wood tracheid walls (30), field pitting uniseriate, terminal parenchyma (cf. 27) usually wanting — *Pseudotsuga.*

7. Spiral thickenings confined to late wood if present, field pitting uniseriate to biseriate, terminal parenchyma present or wanting 8

8. Field pitting consistently uniseriate, terminal parenchyma wanting, (5) festoons scattered — *Picea.*

8. Field pitting occasionally biseriate, terminal parenchyma often conspiciuous (6, cf. 27), canals concentrated in latest wood — *Larix.*

CEDROXYLON

9. Resin canals in vertical alignment only, then in festoons (7), or occasionally in traumatic rows — *Keteleeria.*

9. Resin canals confined to traumatic rows (8-10), accompanied by (large) horizontal canals in *Cedrus* only (8, cf. 21) ..... 10.

10. Large conspicuous horizontal canals associated with traumatic canal rows (8, cf. 21) — *Cedrus.*

10. Traumatic canal rows occasionally present but no fusiform rays (22) ..... 11.

11. Parenchyma wanting, no ray tracheids, (9),(22) — *Abies.*

11. Terminal parenchyma typical, ray tracheids present or sporadic on ray margins ..... 12.

12. Ray tracheids on most margins (26) — *Tsuga.*

12. Tracheids suggested by shape of marginal cells but for most part "ghost" cells only (27),(10) — *Pseudolarix.*

CUPRESSINOXYLON

13. Traumatic canal rows associated with diffuse parenchyma, often coarse textured wood (11) — *Sequoia.*

13. No traumatic rows present, parenchyma typically abundant (11-16), texture fine to coarse — Cupressinoxylon ..... 14.

14. Tracheid pitting in multiples up to 3-4 (31), rays rarely low (maximum), usually coarse textured woods (12,13) — Taxodioxylon ..... 15.

14. Tracheid pitting less than 3-seriate, rays typically low (cf.24), usually fine to medium textured woods (14-16) — Thujoxylon ..... 16.

15. Field pitting strictly uniseriate and typically bordered, ray walls essentially smooth	*Sequoia* (?) or *Taxodium* (?)
15. Field pitting tending to be multiseriate, pits large and essentially simple, transverse ray walls slightly pitted	*Glyptostrobus.*
16. Tracheid pits associated with characteristic membranes (29), tracheids rounded (16)	*Callitris.*
16. No peculiar tracheid membranes, tracheids typically squarish to hexagonal in shape.....17.	
17. Tracheids conspicuous in low rays and locally on the margins of larger (25)	*Chamaecyparis.*
17. Ray tracheids typically wanting	refer all of these back to the generalized Cupressinoxylon type.

TAXOXYLON

18. Spiral thickenings conspicuous (cf.30) associated with diffuse parenchma (cf.11-16),23	*Spiropitys.*
18. Spiral thickenings not associated with parenchyma of any type (17-18)	Taxoxylon .....19.
19. Spirals evenly spaced, texture fine (18)	*Taxus.*
19. Spirals tending to be paired, texture medium (17)	*Torreya.*

CHANGES IN NAME

1. *Piceoxylon pseudotsugae* Gothan = *Pseudotsuga pseudotsugae.*
2. *Pityoxylon krausei* Felix = *Coniferoxylon krausei.*
3. *Sequoia magnifica* Knowlton = *Cupressinoxylon eutreron* Felix.
4. *Sequoioxylon pearsalli* Andrews = *Cupressinoxylon pearsalli.*
5. *Cupressinoxylon* sp. (1540) in "Fossil Woods of the Far West," Vol. 1, No. 3, June 1941, here changed to *Chamaecyparis* (?) sp.
6. *Cedroxylon* sp. (625) Ibid, Vol. 1, No. 4, here changed to *Torreya* sp.
7. *Abies* (?) sp. 757 Ibid, Vol. 1, No. 9, here changed to *Pseudolarix* (?) sp.

Discussion.—(1) Since Krausel (1919) and Seward (1919) both have accepted this California wood as the counterpart of the modern Douglas fir (*Pseudotsuga taxifolia*) there should be no hesitation in making the transfer. Fossil woods referred by me to this nominal Tertiary species have not revealed terminal parenchyma, but this is a variable feature and hardly a valid reason for recognizing two species.

(2). The chief difficulty in the way of referring this anomalous wood to *Pityoxylon* (Felix, 1886), is the failure to find pitting of any sort on the ray-cell walls. Another difficulty is presented by the diffuse parenchyma which does not appear in modern representatives of the *Pityoxyla.* This latter feature does not exclude this wood from *Cedroxylon,* considering the occurrence of diffuse parenchyma in certain modern firs, but the lack of abietineous pitting and any hint of alternate (tracheid) pitting does.

Horizontal canals, both small (normal?) and large (traumatic?) are not known to occur in modern *Cupressionxylon* or *Taxoxylon* counterparts. There seems no alternative left other than to create a special, non-committal cate-

gory, for which I have chosen Cramer's (1868) "Coniferites" (*oxylon*).

(3). Authors have agreed on the absence of traumatic canal rows in Yellowstone "sequoias" (Felix, 1896; Read, 1930). Not only do canals fail to appear, but there is also an absence of multiseriate (3-4) pitting in even spring wood tracheids. In addition, Read mentions *small* field pitting. There seems to have been no valid reason for the removal of this wood from Felix's *Cupressinoxylon eutreron,* nor does more than one nominal species seem to be represented.

(4). This wood could hardly represent a valid *Sequoia.* In opposition to such a reference, or to anything more definite than *Cupressinoxylon,* are (a) the failure of traumatic canals to appear in many specimens (Andrews, 1936), (b) the absence of multiseriate (3-4) pitting in even the comparatively huge tracheids, and (c) conspicuous pitting on transverse ray-cell walls. I have made no attempt to evaluate the peculiar trahceid septations.

In view of the fact that all or most of these Tertiary woods have counterparts among fossil leaves and fruits that have already been named, it seems unwise to further complicate the synonomy with additional specific names. Nor are we ready, at this time, to evaluate the various species within a given genus to point out the possible equivalents—woods, fruit, foliage. On the other hand, there seems no good reason for not referring equivalent generic wood types to the essentially monotypic, western Tertiary species, *Ginkgo adiantoides, Sequoia langsdorfii, Taxodium dubium* and *Glyptostrobus europeaus.*

DESCRIPTION OF FIGURES*

Fig. 1. *Ginkgo adiantoides* (Unger) Heer, 756, Tr. x 32 (10x10), Vantage. Washington. Generalized type with narrow rays and no parenchyma; tracheids rounded and variable in size.

Fig. 2. *Coniferoxylon krausei* (Felix) Beck, 766, Tr. x 32 (10x10), Beach, North Dakota. Large horizontal canal upper left; several parenchyma cells, lower right; traumatic canal row, bottom.

Fig. 3. *Pinus* sp. 1567, x 8 (10x2.6), Chehalis, Washington.

Fig. 4. *Pseudotsuga psudotsugae* Gothan) Beck, 1726, Tr. x 12 (10x2.6), Squaw Creek, Washington. Apparently normal "festooned" canals, upper; traumatic canal row, lower.

Fig. 5. *Picea* sp. 164, Tr. x 18 (10x6), Vantage, Washington. Festoon of 3 canals, upper center; large canal-bearing ray, extreme right. (Discolored cells here are not parenchyma).

Fig 6. *Larix* sp. 2162, Tr. x 18 (10x6), Fall Cr., Oregon. Two canal groups in latest wood. Dark, apparently parenchyma, cells on face of summer wood.

Fig. 7. *Keteleeria* sp. 1129, Tr. x 12, (10x6), Eugene, Oregon. Canals scattering in small multiples, no fusiform raps apparent.

Fig 8. *Cedrus penhallowii* (Jeffrey) Barghoorn and Bailey, 1366, Tr. x 18 (10x3.2), McCord Cr., Oregon. Two traumatic canal rows connected by large fusiform ray.

Fig. 9. *Abies* sp. 1114, Tr. x 18 (10x6), Vantage, Washington. Conspicuous traumatic canal row.

Fig. 10. *Pseudolarix* (?) sp. 757, Tr. x 18 (10x6), Rainbow Ridge, Nevada. Conspicuous traumatic canal row. Terminal parenchyma hardly apparent at this magnification.

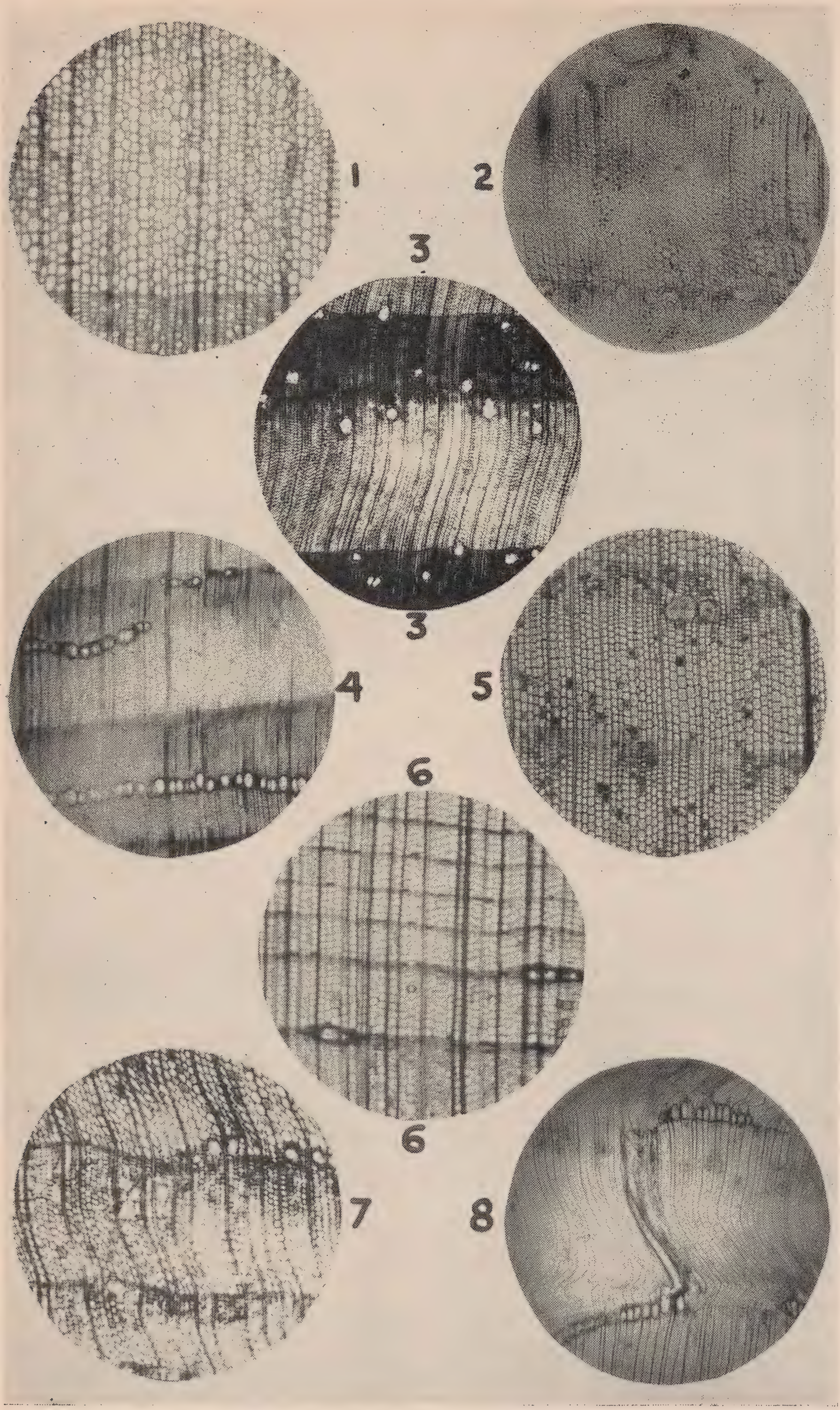
Fig. 11. *Sequoia langsdorfii* (Brongniart) Heer. 1257, Tr. x 18 (10x6), Roosevelt, Washington. Traumatic canal row conspicuous, diffuse parenchyma sparse and hardly apparent.

Fig. 12. *Taxodium dubium* (Sternberg) Heer. 96, Tr. x 12 (10x3.2), Yakima Canyon; Roza, Washington. Parenchyma diffuse to almost zonate.

Fig. 13. *Glyptostrobus europeaus* (Brongniart) Heer, 1088, Tr. x 18 (10x6), Vantage, Washington. Parenchyma diffuse and late wood zone reduced to one cell and hardly apparent.

*Figures in parenthesis refer to ocular and eyepiece respectively as employed in photographing the specimens. The reduction is about two-thirds from the original negatives. The stated magnifications are approximations only.

Tranverse views are indicated by Tr., radial by Ra. and tangential by Ta.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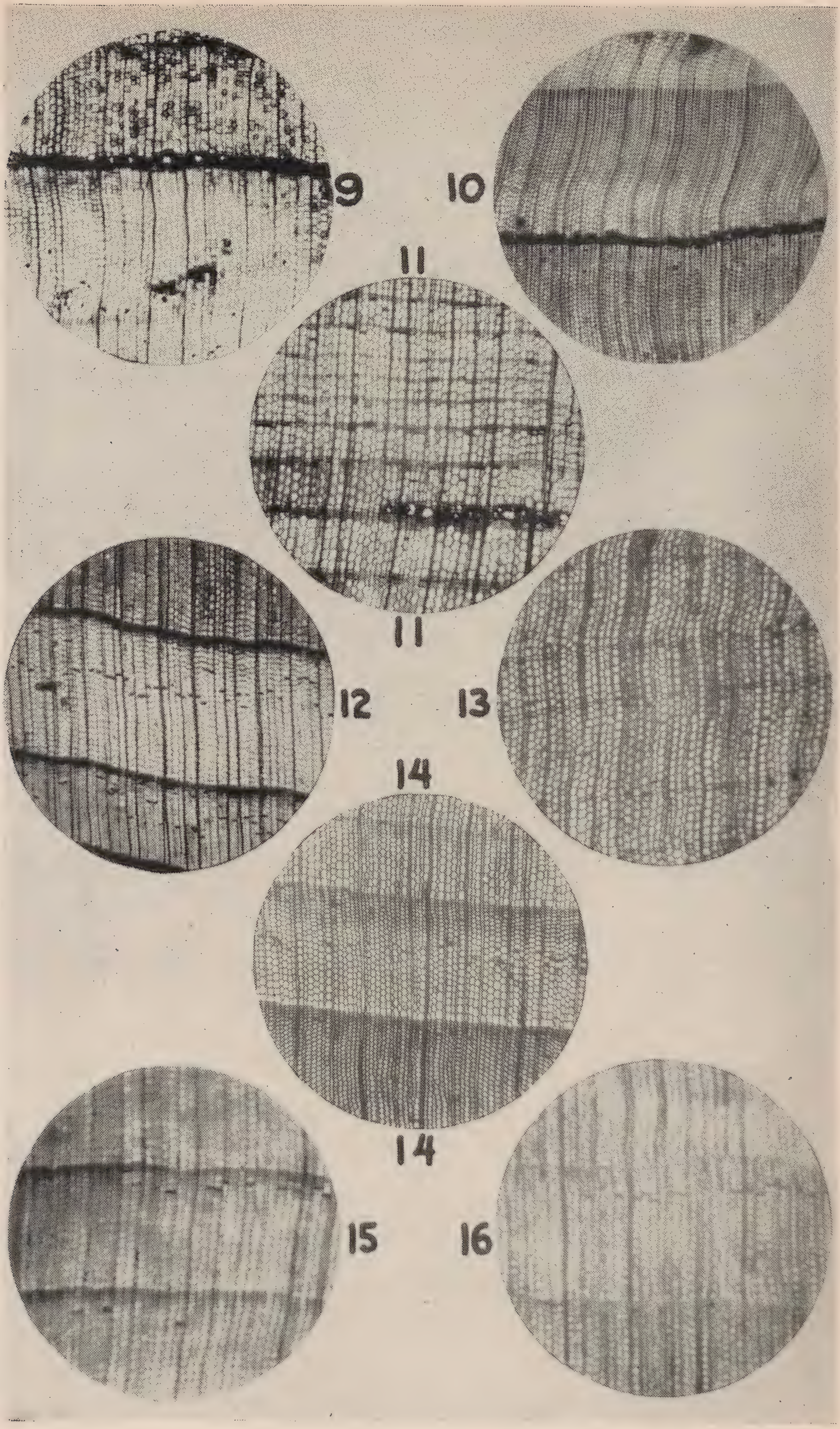
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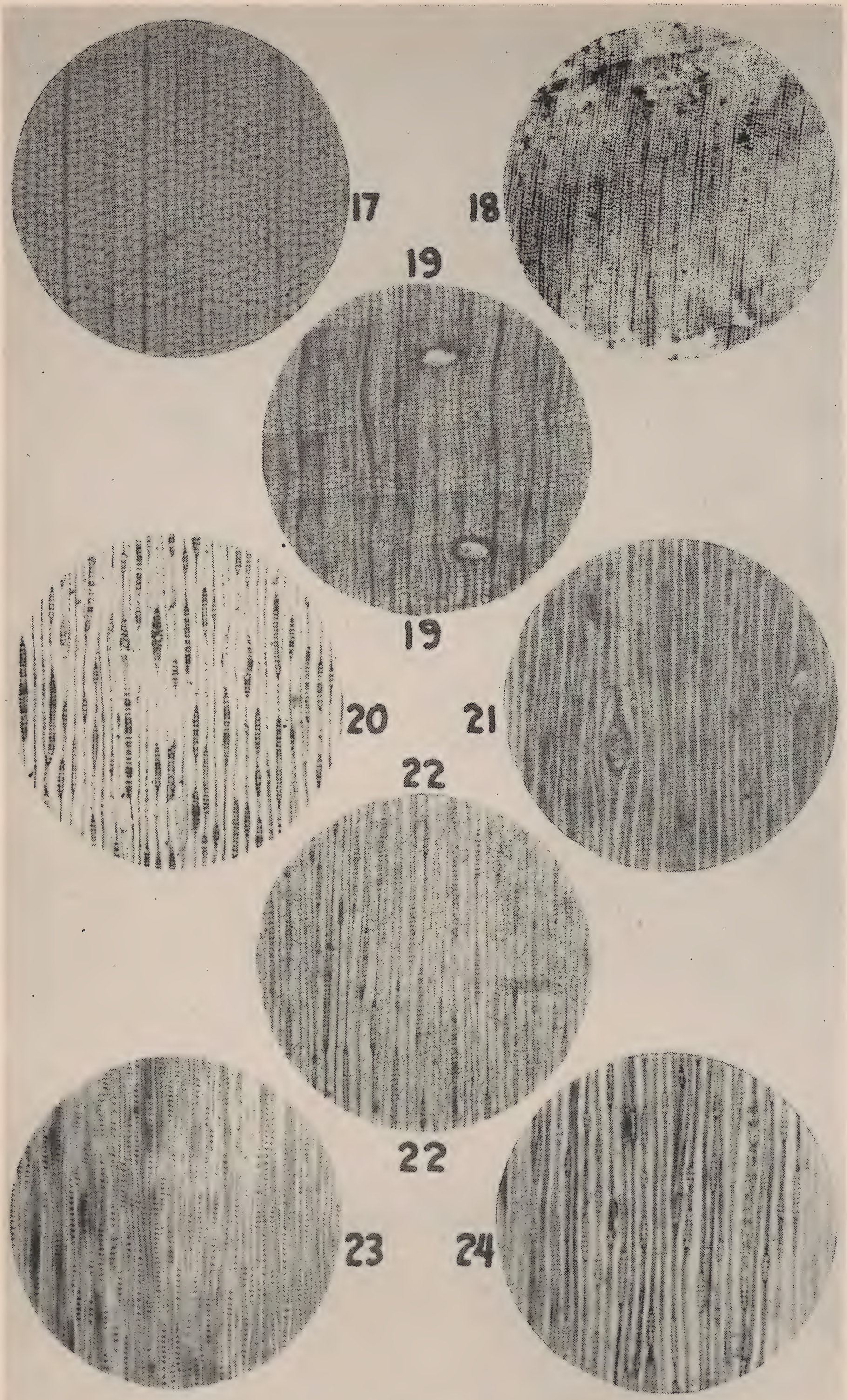
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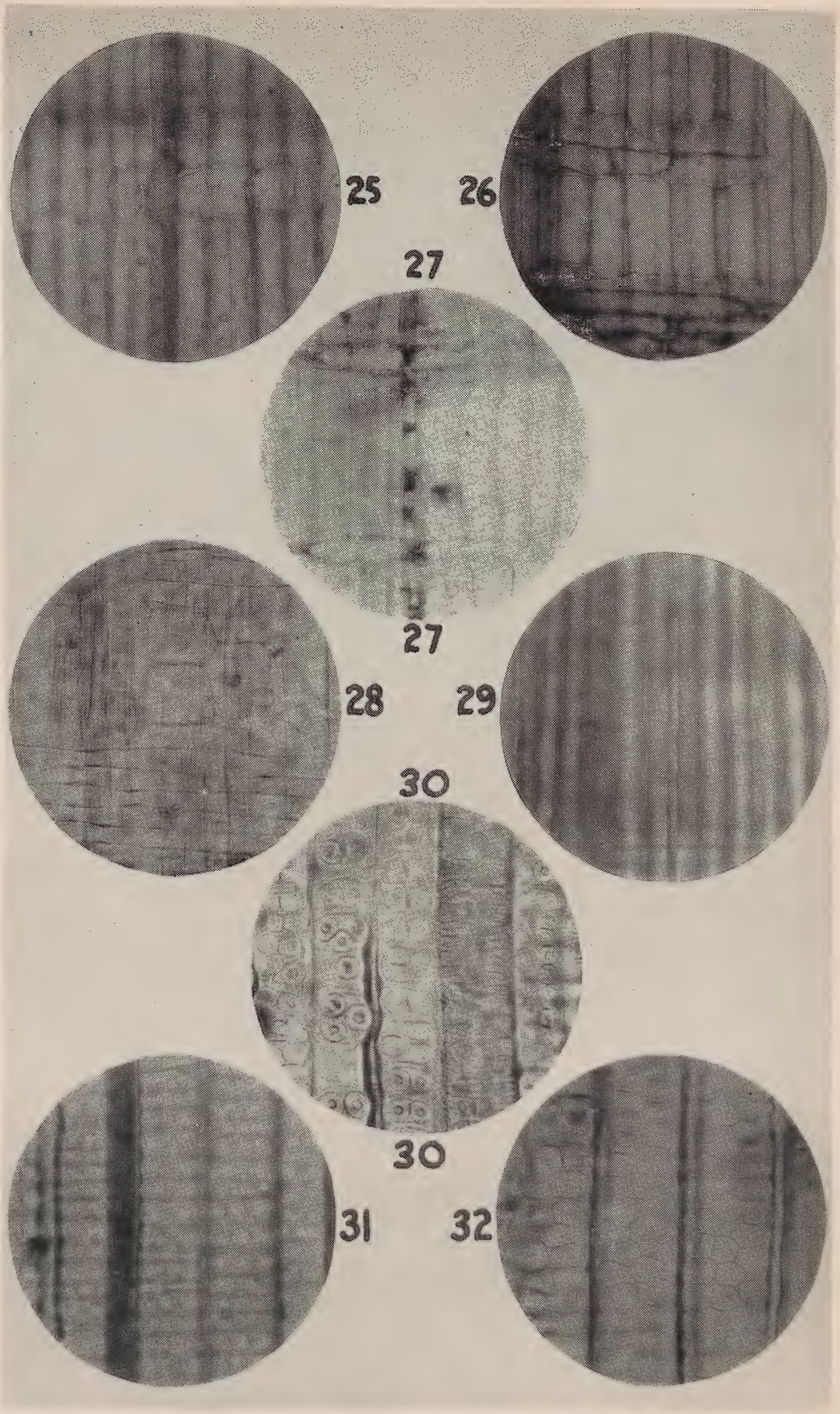
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Fig. 14. *Thujoxylon* sp. 1917, Tr. x 32 (10x10), Thorp, Washington. Parenchyma conspicuous.

Fig. 15. *Chamaecyparis* (?) sp. 1540, Tr. x 32 (10x10), Rainbow Ridge, Nevada. Parenchyma conspicuous.

Fig. 16. *Callitris* sp. 1618, Tr. x 32 (10x10), Vantage Washington. Zone of diffuse parenchyma, tracheids well rounded, and late wood zone narrow, and transitional.

Fig. 17. *Torreya* sp. 625, Tr. x 32 (10x10), Vantage, Washington. Generalized type with small rays, without parenchyma, and tracheids hexagonal.

Fig. 18. *Taxus* sp. 853, Tr. x 18(10x6), Vantage, Washington. Fine textured wood with tracheids rounded. (Discolored cells here are not parenchyma).

Fig. 19. *Pinus kelloggi* Webber. 1817, Tr. x 32 (10x10), Birch Cr., Pendleton, Oregon. Two isolated resin canals each surrounded by a zone of broken down epithelial cells.

Fig. 20. *Piceoxylon* sp. 184, Ta. x 32 (10x10), Vantage, Washington. Two fusiform (canal-bearing) rays at left of center. Specimen probably referable to *Pseudotsuga*.

Fig. 21. *Piceoxylon* sp. 952, Ta. x 32 (10x10), Rainbow Ridge, Nevada. Two extremely large fusiform rays.

Fig. 22. *Abies* sp. 1114, Ta. x 32 (10x 10), Vantage, Washington. All rays uniseriate and of medium maximum height.

Fig. 23. *Spiropitys* sp. (?) 1598, Ta. x 32 (10x10), Chehalis, Washington. Rays medium maximum height and crowded. Anomalous tracheid septations (parenchyma?) hardly apparent at this magnification.

Fig. 24. *Ginkgo adiantoides* (Brongniart) Heer. 756, Ta. x 32 (10x10), Vantage, Washington. Low uniseriate rays, cells well rounded, with strand of swollen cells extending from ray at right center.

Fig. 25. *Chamaecyparis* (?) sp. 1540, Ra. x 170 (10x43), Rainbow Ridge, Nevada. Ray one cell high made up of tracheids.

Fig. 26. *Tsuga* sp. 2100, Ra. x 170 (10x43), Virgin Valley, Nevada. At upper center, ray two cells high made up of 3 tracheids (bordered pits) and 2 parenchyma cells (abietineous pitting). Lower center, ray with tracheid on margin, only.

Fig. 27. *Pseudolarix* (?) sp. 757, Ra. x 170 (10x43), Rainbow Ridge, Nevada. Strand of terminal parenchyma. Two low (1-celled) rays revealing abietineous pitting and ghost marginal cells.

Fig. 28. *Ginkgo adiantoides* (Brongniart) Heer. 756, Ra. x 170 (10x43), Vantage, Washington. At center, large swollen parenchymatous cells. Lower center, ray cells without apparent pitting.

Fig. 29. *Callitris* sp. 1618, Ra. x 170 (10x43), Vantage, Washington. At center, tracheids with membranes flanking the inter-tracheid pits.

Fig. 30. *Pseudotsuga pseudotsugae* (Gothan) Beck. 1726, Ra. x 170 (10x43), Squaw Creek, Ellensburg, Washington. Left center, tracheid with several clustered pits. Right center, early wood tracheid with conspicuous spiral thickening.

Fig. 31. *Sequoia langsdorfii* (Brongniart) Heer. 1257, Ra. x 170 (10x43), Roosevelt grade, Roosevelt, Washington. Abundant 3-seriate pitting of the strictly opposite type set off by crassulae.

Fig. 32. *Cedroxylon* sp. 1139, Ra. x 170 (10x43), Chehalis, Washington. Tracheid pitting of the alternate (3-seriate) type.

DISCUSSION OF DIAGNOSTIC FEATURES

Resin Canals.—These features, which represent open wells (curbed with cells) in the tissue, provide a ready but somewhat artificial means for a two-fold division of fossil and modern conifers under the hand lens; cols. 2,10-21,29; figs. 2-11,19-21.

(1) *Normal Canals Vertical.*—These are more or less evenly distributed through most annual rings in the *Pityoxylon* types and in *Keteleeria*.

(a) *Vertical Canals Scattering.*—In the pine types the canals are found to be scattered mostly as single individuals, infrequently as pairs and rarely in multiples of a few. Moreover the individual canals tend to be round and in the ag-

gregate, equidimensional, though often surrounded by irregular zones of broken down epithelial cells. When seen in longitudinal view each strand remains relatively non-constricted. These canals are not found in traumatic rows. They are indicated by (S) in cols. 15-16; figs. 3,19.

(b) *Vertical Canals Festooned.*—In the *Cedroxylon* and *Pityoxylon* categories, and *Keteleeria,* the vertical canals occur in more or less curved, tangential chains of from several to many. More rarely they are solitary, especially in fast-growth wood. The individual canals tend to be oval and to be constricted into segments (a reason for variable diameter) when seen in longitudinal view. Indicated by (F) in cols. 10-14,19; figs. 4-7.

(2) *Vertical Canals in Traumatic Rays.* — *Piceoxylon* and *Cedroxylon* types, as well as *Sequcia langsdorfii,* on occasion exhibit continuous tangential canal rows that are said to be a response to injury. They are usually well distributed through the annual rings in *Coniferoxylon krausei* but typically appear only in widely separated annual rings; Cols. 10-12, 13(?),14,17-21,29; figs. 2,4,8-11.

(3) *Resin Canals Horizontal.*—In association with vertical canals, these canals are to be found in fusiform rays. In a few fossil conifers these horizontal canals reach a huge maximum indicated in the table by (L): cols. 10-16,18,29; figs. 5,8,20,21.

(4) *Rays Uniseriate.*—Unless bearing canals the rays of the conifers typically remain one cell wide, though a variable number of them may be biseriate in part. Where the rays are non-fusiform as a whole they have been checked; cols. 1-9,17, 19-28; figs 22-24.

(5) *Ray Maximum Height.*—The rays within a given specimen may vary many times in height, but two extremes, unusually low maxima and extremely high maxima can usually be recognized. Rather arbitrarily a maximum of 12-30 has been chosen as the medium type separating these two extremes, yielding a three-fold classification. Low maximum rays are indicated by (L); cols. 4,6, 7,26,28; fig. 24; medium maximum rays by (M); cols. 1,5,8-10, 13-17, 19-21,24, 27,29; figs. 20-23; high maximum rays by (H); cols. 2,3,11,12,18,22,25; (no ill.).

(6) *Tracheid Radial Pitting.*—Certain coniferous woods in response to maximum tracheid diameters display intertracheid pitting of more than one or two rows. The letter (M) indicates multiseriate 3-4 pitting of this character; cols. 1-3,19,22; figs. 31,32.

(7) *Tracheid Pitting Alignment*—Among the Tertiary conifers herein considered, there is an absence of true over-all, alternate position of the intertracheid pits. However, there is a strong tendency for strict opposition to pass over into clusters (pits often flattened by contact but all in one primary pit field and flanked by a pair of crassulae). No distinction in these two phases is made in the table and both are indicated by (O); cols. 1-16,24-29; figs. 30,31. The *Cedroxyla* on the other hand reveal a tendency toward alternation *locally,* a condition reaching its culmination in *C.* sp. 1139; col. 22; fig. 32.

(8) *Cross-Field Pitting.*—The number, size, and alignment of the cross-field pitting is often obscured by darkened contents or by deterioration. In a few cases the condition is beautifully preserved as in *Thujoxylon* sp. 1601; col. 6; and *T.* sp. 1917; col. 7 (no ill.). Exclusive of the pines, there seems to be a marked tendency for these Tertiary conifers to reveal a strict uniseriate cross-field alignment of average-sized, bordered pits. Most of the types questioned (?) belong to this category but only those checked (U) assuredly do; cols. 2,3,5-9,11,12,18,26; (no ill.). Only locally do *Glyptostrobus* 1088 and *Larix* 2162 exhibit irregular, or biseriate field pitting, (B) cols. 1 and 10; (no ill.). The pines are variable, (V); col. 16; (no ill.).

(9) *Ray Wall Pitting.*—The tangential and/or the transverse walls of the ray cells are sometimes heavily pitted (notched). This is frequently hard to establish because of advanced decay, and it is often hard to determine whether the wall pitting is absent or only apparently so. Clear evidence of the so-called abietineous pitting as in the *Piceoxyla* and *Cedroxyla* and certain

pines (including *Pinus kelloggi)* have been checked (A); cols. 10-12,14,15,17-23; figs. 26,27. Conspicuous pitting of non-abietineous type has been noted with (N) (transverse walls only); cols. 5,8,24; fig. 28. No use has been made of pitting on the end (tangential) wall of the ray cells nor has it been conspicuous, except in the abietinean types where the presence of deep regular pits (often filled with discolored material) helps establish this manner of pitting. It remains to be emphasized that marginal cells and ray tracheids generally are *not* employed for this classification. *Pinus* spp. as a group are variable (V) col. 16. Intermediate pitting has been indicated by (I).

(10) *Longitudinal Parenchyma* — Strands of longitudinal parenchyma characterize some woods. In some conifers these relatively short and discolored cells are to be found more or less scattered (or zonate) throughout the various annual rings, indicated by (D); cols. 1-9,29; figs. 2,11-16. In other conifers the parenchyma is confined to a terminal position "on the face of the summer wood" (T); cols. 10,12?,20,21; figs. 6,27. There is a septate tracheid resembling parenchyma but not typically such, diffused through *Spiropitys* 1598; col. 24; fig. 23.

(11) *Ray Tracheids.*—These cells occur on the margin (occasionally interspersed in *Pityoxyla)* of ray cells where they stand out by their shape, lack of color and peculiar (bordered) pitting. Not all undulate, marginal cells, however are tracheids, and various degrees of transition between normal and tracheid ray cells seem to occur. Only clear cases, as determined by border pits in cross-section on end or transverse walls, have been listed as ray tracheids; cols. 5,10-12,14-16; fig. 25; *Chamaecyparis* (?) 1540 and *Pityoxylon* types. Among the *Cedroxyla* ray tracheids are consistently present (more than half of the time) in *Tsuga* 2100, col. 21; fig. 26; but only ghost-like and sporadic (S) in *Pseudolarix* (?) 757; col. 20; fig. 25; and missing entirely among the others.

The ray tracheids in *Pinus kelloggi* 1817 are non-dentate (supported by tangential tracheid pitting) (N) which seems to be the case for *Pinus* spp. 1196, 1567 and 2136. In *Pinus* spp. 688,1382 and 1390 the tracheids are clearly dentate (and tangential pitting seems to be wanting); (V) col. 16; (no ill.).

(12) *Spiral Thickenings.*—These are often overlooked until suspicion of a given genus (on other grounds) leads to a determined search in the better preserved areas. They have been found in early wood (as well as in the late wood and ray tracheids) of *Pseudotsuga* 1726, indicated by (E); col. 12; fig. 30. They are clearly present in *Taxus* 853; col. 26; (no ill.); and have been seen paired occasionally in *Torreya* 623; col. 27; (no ill.). No traces have been seen in woods here placed in *Picea* or *Larix* but it is always difficult to guarantee that spiral thickenings have not been lost through decay.

(13) *Texture.*—Some woods are typically coarser grained than others. Tangential diameter of early wood tracheids is here taken as the index of texture, the figures from 25-100 (microns) in a general way indicating the diameter of individual tracheids. These fossil woods range somewhat coarser than their modern counterparts.

(14) *Miscellaneous Considerations.*—In *Ginkgo* 756 and 805 are to be found swollen parenchymatous cells not typical of longitudinal parenchyma; fig. 24 (right), and 28 (center).

Rays are densely crowded in *Spiropitys* (?) 1598; fig. 23; and extremely high in *S.* 2033; (no ill.).

Late wood zones are exceptionally narrow in *Glyptostrobus* 1088; col. 1; fig. 13.

Callitris 1618; col. 5; fig. 29; exhibits the tracheid pit membranes so characteristic of some species of the genus.

Taxodium 96 is adjudged to be this genus partly on the basis of a tendency toward gray color, and partly on association with tupelo (*Nyssa*), water ash (*Fraxinus*) and persimmon (*Diospyros*).

Larix 2162 col. 17; fig. 6; shows a concentration of the resin canals in the very late wood zone.

AN EXPERIMENT IN EDUCATION
THE ARMY AIR FORCES COLLEGE TRAINING DETACHMENT[1]
EASTERN OREGON COLLEGE OF EDUCATION

ROY L. SKEEN AND ROBEN J. MAASKE[2]

In the larger symposium to which the colleges and universities of the Northwest are contributing, the question that is being asked of all institutions is *What were the Lessons in Your Military Training programs for Science Education; for Education in General?*

The Army Air Corps College Training Detachment program was inaugurated at Eastern Oregon College of Education on March 31, 1943, with a contingent of 500 students, and terminated on June 30, 1944. During this period of approximately fifteen months, 2102 men were sent to this college for instruction in Physics, Mathematics, Geography, History, English, Medical Aid, Physical Training, and Civil Air Regulations.

In addition, the students received training in military conduct and learned the rudiments of flying in a ten-hour course at the La Grande Airport. The program was originally planned so that each squadron of one hundred men would remain for a period of twenty-one weeks, but in actuality the length of time each group of students was in attendance varied from only seven weeks for one squadron to twenty-two weeks for another group. The average length of time for all the squadrons for the period of fifteen months was seventeen weeks.

The AAFCTD program brought to this campus many interesting and stimulating military officials, permanent military party personnel, aviation students and new faculty members. It began at a time when the drafting of young men into the Armed Forces had removed most of the young men and reduced a student body that had been about fifty per cent men students to a student body made up largely of women. During the time this program was in operation on the campus it added color, enthusiasm, new experience, and worthwhileness to the entire college atmosphere.

Several weeks before the close of the AAFCTD program at Eastern Oregon College, steps were taken to secure an appraisal of the program from members of the faculty who had been connected with its operation. Each instructor was asked to give his frank reactions to the following questions:

1. From an instructional standpoint, what have been the strong points of the AAFCTD program?

2. From an instructional standpoint, what have been the weak points of this program?

3. List five or more educational and psychological principles, suggestions, and conclusions that have been substantiated by this program.

4. Comment briefly on your own professional growth resulting from your experience in this program.

5. If this program were to be started all over again, what suggestions would you have for improving on the job that has been done?

The following paragraphs contain a summarization of the replies given by instructors to each of these questions, with some interpretations based upon discussions that followed the survey. An attempt has been made to summarize fairly the returns to these questions and to express the conclusions of the majority of the faculty.

---

[1] This is the ninth article in this series. Copies of this and preceding articles may be secured from J. W. Hungate, Eastern Washington College of Education, Cheney, Washington.

[2] Associate Professor of Psychology and President, respectively, Eastern Oregon College of Education, La Grande, Oregon.

1. *From an instructional standpoint, what have been the strong points of the AAFCTD program?*

In general the results of this survey of faculty opinion indicated that all the faculty members felt the program had been a worthwhile experience for each individual faculty member as well as for the aviation students and the institution. In listing the strong points of this program, several aspects were mentioned by most of the instructors.

(a) All the instructors mentioned the interest, enthusiasm and high degree of motivation that was very noticeable on the part of most of the aviation students. The instructors felt that the academic morale among the students was particularly high, especially when the aviation students believed that the subject matter of a course had a definite bearing on their immediate objectives of becoming pilots, bombardiers or navigators. The program demonstrated very clearly the importance of keeping the instructional program on the maturational level of the students' purposes and needs.

(b) Likewise, the replies to the questionnaire indicated that the program had much potential professional motivation for the faculty members. There was a definite feeling on the part of all the instructors that they were making a real and significant contribution toward the war effort. They were earnest in desiring to give the aviation students as much vital information and understanding as possible in order to increase the effectiveness of these prospective aviators.

(c) The instructors, also, felt that the supervision from the Army Headquarters was helpful in maintaining a high academic morale among the faculty as well as the students. At times some frustration was experienced because of the inability of various departments to determine just what was wanted and needed in such a program. Nevertheless, the instructors felt that the supervisory visitations of Army personnel officers, bulletins and directives from the West Coast Flying Command Headquarters, and results of tests given to the students who were sent to the air base at Santa Ana, tended to keep them motivated and interested in giving a high degree of professional service.

(d) The professional enthusiasm on the part of the faculty led to several worthwhile cooperative undertakings. In addition to frequent faculty meetings to discuss pertinent problems relative to the objectives and functions of the program, weekly departmental meetings were held to discuss specific problems in each field. In these departmental meetings time was devoted not only to the development of course outlines, lesson plans, syllabi, drill sheets, subject tests and teaching aids, but some time was also spent in discussing specific student personnel problems. These departmental meetings served to help each instructor analyze his function in the program and to focus the attention of all the instructors upon the essential objectives of each department. These meetings also served as a "clearing house" for practical suggestions on how the program could be improved.

(e) Growing out of these discussions of student problems was the development of plans for individual-help sections for weak students which proved very beneficial. In these remedial sections, faculty members not only gave assistance in subject matter but they frequently counselled with the students about personal matters that had a bearing upon the adjustment of the students to the program as a whole, but the willingness of the faculty members to devote additional hours of service to the students, over and above their regular teaching loads, was an example of the fine spirit of cooperation and service found in this program from the beginning.

2. *From an instructional standpoint, what have been the weak points of this program?*

Some of the weak points of the program mentioned in this study were not inherently a part of such a program, necessarily, but resulted no doubt from the speed with which the whole program was conceived and developed.

(a) From the beginning it was found desirable at this institution to group the men on the basis of their demonstrated ability in mathematics, science and general scholastic ability. Frequently, the aviation students were transferred from one squadron to another and from the detachment at Eastern Oregon College to an advanced training base before they had completed their scheduled courses. From an instructional standpoint this common practice was found very undesirable although it may doubtless have been justified by military expediency.

(b) The indefiniteness of the original course objectives and outlines in the various fields led to confusion, wasted motion, and some frustration. This confusion was especially noticeable in the field of History.

(c) Several instructors also mentioned in the replies that the mistaken impression that some students received from non-academic personnel that the academic was less important than other parts of the program presented a situation that could have developed into a serious instructional problem. Fortunately, this misconception did not develop into an acute problem at this institution.

(d) The instructors mentioned that the frequent disruption of the academic schedule, including the study hours, in order that students might perform military assignments or fill in flying groups, tended to reduce the efficiency of the academic program.

(e) A number of instructors also concurred in the opinion that the program tended to over-memorization without giving sufficient emphasis to the building of concepts and basic understandings.

3. *List five or more educational and psychological principles, suggestions, and conclusions that have been substantiated by this program.*

The instructors were interested in comparing the instructional methods of handling men utilized in the Army program with the methods ordinarily employed in college teaching. At the conclusion of the program they agreed upon the following general statement:

(a) The program has demonstrated the advisability of using positive methods in instructing students; however, certain situations in this program have indicated that there are times when the negative approach may be more effective in obtaining immediate results and ends.

(b) The program pointed definitely to the desirability of fairly homogeneous groupings in attempting to teach specific, definite material. It was found especially important to group the men on the basis of ability and background for instruction in mathematics and physics. There was a wide range in the educational training of the aviation students. A study of 1400 men showed a range in education from seventh grade to six years of college with the average being four years of high school. Likewise, tests in arithmetic showed a range from sixth grade ability to above eleventh grade ability. Results of intelligence tests indicated that the Army aviation students compared fairly well with an average group of college freshmen. With these wide ranges in educational backgrounds and abilities it was found desirable to group the students for instructional purposes in mathematics and science. However, all the instructors were impressed with the extent to which out-of-school experience, intelligence, and motivation could compensate for lack of previous formal education in the classroom.

(c) The instructors emphasized in their replies the desirability of having the same instructor continue with a group of students until they had completed a given course even on the college level. This conclusion was

based upon several months' experience during which time instructors were shifted frequently from one group to another group to accommodate the flying schedule.

(d) According to this survey, the experience of this institution would indicate that it is not desirable to study a course in large blocks daily for a short period of time. Even a high degree of motivation on the part of both the teacher and the student cannot force the individual much beyond an optimum pace for acquiring new learnings. Eventually such factors as physical fatigue, intellectual boredom, and need for time in which to digest, assimilate, and integrate the material in a course will make additional time spent on any subject increasingly unprofitable. Spaced learning is very desirable in arranging a schedule of classes for optimum learning.

(e) The replies from most of the instructors indicated that the effort to correlate the work of the different courses and departments was very effective and worthwhile. It was found that in order to accomplish an optimum amount of correlation, instructors need to become familiar with the content of all the courses the students are taking and know approximately when the various units in each course are being presented.

(f) The replies indicated that the instructors believed that college teaching can be improved by adhering more closely to the simple teaching procedures which were emphasized by the supervisory staff and the Army officials. Several suggestions were listed which the instructors believed were effective teaching devices. For example, one instructor said that the program had demonstrated very clearly that it is desirable to make specific assignments and to make certain that the material covered each day is understood by all the students before going on to new material. Another instructor said that his experience in teaching the young men in this program brought out that each day's lesson should be organized in clear cut teaching units and each unit must be definitely related to the needs of the students. The presentation and discussion of each unit should be carefully planned to bring about an optimum amount of understanding on the part of each student.

Another instructor mentioned that he had found it a good practice to list the major topics or questions on the board at the beginning of the instructional period. These topics, broken down into their principal parts and presented in proper sequence, proved very effective. Several instructors mentioned that the teacher should "draw out" contributions to the discussion by calling on individual students by name. They found seating charts very helpful in learning readily the names of the students in the classes and in saving much time in distributing papers. All the instructors agreed that it was a good plan when a student asked a question, or made a recitation that he should talk to the class and not to the instructor, in complete sentences and in a voice loud, clear, and distinct so that it would be evident where the attention of the class should be directed. They also mentioned that it was desirable for the instructor or a student to give a brief summary of the important points covered in the day's discussion at the close of the period.

4. *Comment briefly on your own professional growth resulting from your experience in this program.*

The personalized nature of the answers to this question made it rather difficult to summarize this section of the questionnaire. However, running through most of the comments were these concepts:

(a) The association with various members of the academic and military staffs and the aviation students contributed materially to the professional outlook and growth of each instructor.

(b) The need to cover a large amount of material in a thorough manner and in a short time with students of varying abilities and backgrounds tended to help the instructor in strengthening his teaching methods and techniques.

(c) The challenge in working out a program to meet a practical need in a national emergency was a definite stimulation to professional growth.

5. *If this program were to be started over again, what suggestions would you have for improving on the job that has been done?*

(a) In replying to this question, the instructors agreed that the academic, military, and flying departments should be more closely coordinated with each department recognizing the problems of the other two.

(b) According to the returns from this question, the instructors favored the introduction of departmental tests as soon as possible, to start remedial instructional periods at the beginning and to provide for definite remedial, individual instruction throughout each course.

In summary, there might be listed a number of benefits which occurred to the college as a result of its various war training programs and activities during World War II. They are as follows:

1. The programs, especially the AAFCTD and the USCNC, provided life, vigor, and color in converting what might have been a rather drab and uninteresting period into one of the liveliest points in the history of the college.

2. The faculty of the college was kept largely intact throughout the war period, ready to assume its significant function in peace-time higher education.

3. A considerable proportion of the faculty acquired valuable professional experience in the adaptation of curriculum materials and instructional methods in accelerated courses to a variety of highly-motivated students.

4. The college as a whole was enabled to discharge its wartime obligations in a highly creditable and distinguished manner.

5. A creditable addition to the good will of the general public toward the college accrued as a result of its part in the common war effort.

6. The college has cause for pride, in which alumni and returning veteran students can join, in having fulfilled its obligation in aiding in the common war effort.

7. The clarification of the aims of the college in serving fully its function of higher educational leadership in its area, in peace as well as war.

8. A considerable amount of valuable instructional equipment and materials were acquired for permanent use.

9. The reputation of having consummated contractual obligations creditably with several agencies of the people's government.

10. The carryover into peacetime college instruction of some of the instructional procedures, including the greater use of audio and visual aids, resulting from experimentation in the accelerated war training courses.

11. The temporary addition of some 20 new faculty members provides a reservoir of demonstrated capability upon which to draw for faculty additions as the peacetime enrollment increases.

12. The potential peacetime continuation of the nursing education program in affiliation with hospital schools of nursing in eastern Oregon as a service to able eastern Oregon young women.

As it looks now to peacetime, Eastern Oregon College of Education believes that it has fulfilled its obligation and responsibility during the critical period of World War II in quite a satisfactory and adequate manner.

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COMMERCIAL PRINTING DEPARTMENT

NORTHWEST SCIENCE

February, 1946

Vol. XX, No. 1

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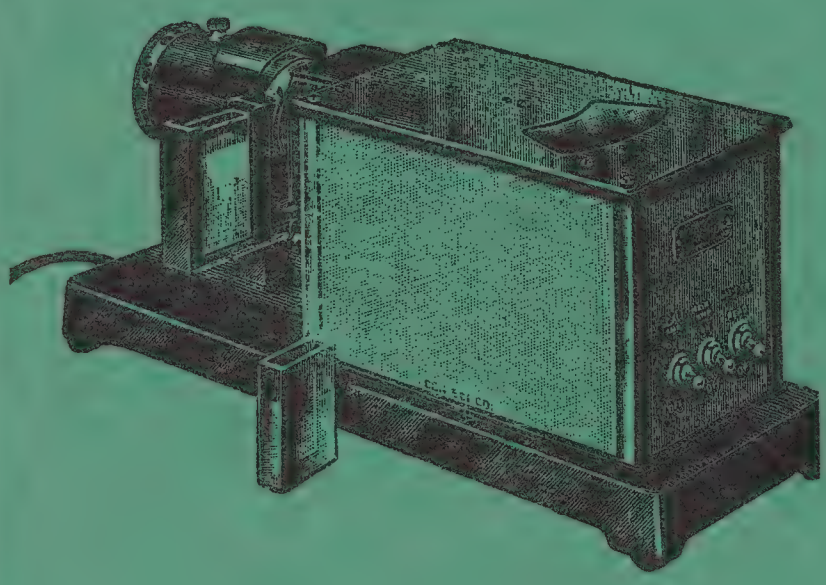

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NORTHWEST SCIENCE

Volume XX, Number 1

1946

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Published quarterly by the Northwest Scientific Association

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

Illustrations and tabular matter together should be limited to approximately twenty per cent of the total number of pages. Authors will be charged at cost rates for illustrations and tabular matter in excess of that amount (approximately $3.70 per page for tabular matter; $7.00 per page for line cuts; $5.00 to $6.00 per page for screen cuts).

NORTHWEST SCIENCE

VOL. XX, NO. 1 FEBRUARY, 1946

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To the Members of the Northwest Scientific Association:

At the annual business meeting on December 28, 1945, your president was instructed by Resolutions Nos. 2, 3, and 4 to appoint three committees as follows:

No. 2. "Resolved that a committee be named to consult with the editor of Northwest Science and to assist him in the appointment of associate editors in the various specialties and to collaborate in collecting, screening and editing papers for Northwest Science."

With the approval of Editor Hatch (1/25/46) I therefore appoint the eight Section chairmen, Church, Davis, Diettert, Gross, Lundy, O'Leary, Schwendiman, and Tascher to serve as ASSOCIATE EDITORS during 1946. Editor Hatch will be chairman of this committee.

No. 3. "Resolved that a committee be named to encourage the participation of amateur scientists in the activities of the Northwest Scientific Association."

As this is clearly an activity in which all Sections should be interested, the eight Section chairmen are again appointed, to serve under the chairmanship of Father O'Leary, S.J. Specific recommendations will be expected from this committee at the 1946 annual meeting.

No. 4. "Resolved that a committee be named to consider the practicability of forming a north coast section of the Northwest Scientific Association."

For this purpose I appoint Dr. G. E. Goodspeed, chairman, Dr. E. C. McCulloch, and Dr. J. W. Sperry. A recommendation to the Association will be expected at the 1946 annual meeting.

Copies of this notice have been sent to each of the chairmen named.

H. T. GISBORNE,

President.

FORESTRY IN A NEW ERA.....Wilson Compton

SOCIAL IMPLICATIONS OF FORESTRY IN THE INLAND EMPIRE .....Baker Brownell

THE SPECIFIC FORESTRY CASE FOR FLATHEAD COUNTY, MONTANA.....George Sundborg

The three papers by Compton, Brownell and Sundborg cover the general, local and specific aspects of a single subject. They were rated by men who heard them as among the most informational papers issued in recent years by foresters anywhere in the United States.

Ours is a region in which choice of crops is distinctly limited by the climate of our mountain areas. Yet even if we could grow cotton on all these mountain slopes we might deliberately choose to grow trees instead. The reasons are, (1) cellulose, lignin, and the other chemical components of trees seem very likely to be among the most widely used agricultural products on which many of our future manufacturing industries will be based. (2) Trees can produce more cellulose per acre per year than any other crop. Even in Georgia it is admitted that trees can produce five times more cellulose per acre per year than cotton. (3) Other crops have to be harvested not only annually but at certain times of the year. Trees can be harvested at any time of the year and if the market is poor this year's crop can be stored without great cost right in the stem of the tree until next year, the year after that, or even 10 or 20 years hence. No warehouses are required for storage of the raw product. (4) When a timber crop is harvested it need not be put into bags, boxes or crates for shipment to the manufacturing plant. And this will still be true even when we someday harvest the branches and even the leaves and stumps of our trees.

These are four basic commercial advantages possessed by trees. Their values are not yet fully apparent but in the "New Era" described by Dr. Compton, we can expect our region to benefit to the full, PROVIDED that we, the present custodians, do our part.

H. T. GISBORNE, President

(Chairman of the Forestry Section of Northwest Scientific Association before whom these three papers were read.)

FORESTRY IN A NEW ERA

WILSON COMPTON

President, State College of Washington

Twenty-five years ago after the First World War the National Lumber Manufacturers Association, of which I was then a part, made a survey of the extent to which private forest owners were practicing forestry on their own lands. This survey found three such ownerships,—one in the West, one in the South, and one in the North, in addition of course to a number of small farm woodland ownerships. In 1933 during the reign of the National Recovery Administration, a similar survey showed between six and seven hundred such ownerships. Today there are few substantial forest ownerships either in the South or the West or the North which are not in one way or another seriously exploring the possibilities of permanent productive use of their forest lands.

A few days ago I received a copy of what is identified as "National Box Score" of Certified Tree Farms included in the system of American Tree Farms which as an officer of American Forest Products Industries I helped to initiate a few years ago. This box score shows, of certified tree farms alone in five states of the South and five states of the West, a total registration of 945 ownerships with an aggregate tree farms area of 11,134,950 acres. This is not a solution, but it is progress. Much of it dates back to a hot afternoon in Washington, D. C., in the summer of 1933 when the Lumber and Timber Products Industries submitted to the National Recovery Administration what later became famous as "Article X — Forest Conservation Code" with these significant words: "This is an industry undertaking. It will be so administered."

I see by the program that I am designated to speak on "Forestry in a New Era." I suppose that in an unguarded moment I myself suggested that title. But I shall use this assigned subject as a text to speak from and as far from as is necessary.

Most speeches on forestry which I have heard in the last quarter of a century, and I have listened to many, have for the most part been either debates over disputed public forest policies or declamations of the advantages of trees and the magnitude of our forestry resources and of the industries using them. But trees grow in the woods and not in the closets of forest philosophers or in the debates which divide foresters, or in speeches by college presidents.

One of my first jobs as a youth was as a log scaler in a small hemlock and hardwood logging camp in northern Michigan. It logged with high wheels and big Percherons. It had infested bunk houses and culinary facilities which would not pass the test of any food sanitary regulations nowadays that I know of. But with all that I learned a love of the woods. And the love of the woods, as you well know, is one of those deep-seated affections which time and circumstance do not alter. So I would rather not take your time or mine either in an unlimited adventure in statistics or a diverting lyric of the beauty of trees or of the annoyance of seeing them cut down, or in an amiable "sparring bout" over public forest policies which have been a source of prolific debate for over half a century.

No one knows better than I do how easy it is to put a statement of good forest practices on paper and how hard it is to convert it into habitual practice in the woods. Also no one knows better, I think, than I do the extent to which unwholesome and sometimes destructive local forest conditions are concealed in the more hopeful national forest industry averages; or the ease with which policy resolutions are adopted in meetings, and the difficulty with

which they are practiced in the woods operations. But with all this and looking back over a quarter century, I think there is a great significance to the fact that representative national spokesmanship for the principal forest industries within a little more than a year has publicly declared itself as favoring the incorporation, into forestry codes to be administered under appropriate state laws, of timber cutting and forest practice rules for continuous forest production based on the tested local or regional experience of forest owners; and the establishment and strengthening of public agencies under state law qualified and competent to administer and enforce forest laws.

This is not an end. But it is more than a beginning. It is in this direction that the states of the Pacific Northwest are headed. The Oregon forest law is a good start. The new Washington law, I think, is still better and provides at least the structure of a competent state forest code and the means of applying and enforcing it. I am not familiar with the Idaho and Montana laws, but I am sure they will be not far behind. The extent in the long run to which Federal forestry control will be involved will, I think, be determined and should be determined by the extent to which individual states show a competence to deal constructively with their own.

Among the new forestry indications, I have mentioned the tree farms movement, already well under way in several states and gaining impetus. Behind all this of course is the still unsolved problem of forest fire protection. No one witnessing the raging forest fire events of last summer will seriously say that that problem has been solved. It may be an insoluble problem and the most that may be expected is that over a period of years we continue to make gains in fire protection and control.

Within the last three years, a stronger economic base has been put under private forest ownership. This is in the recognition in our Federal Revenue System, of increases in the growth and value of standing timber as long-term "capital gains" subject to moderate taxation and not "ordinary income" subject to the high rates which heretofore have applied. This comparatively inconspicuous action of Congress a couple of years ago in recognizing the logic and equity of the capital gains principle for the taxation of "timber income" and its significance to the future of private forestry on a larger scale, is almost a new charter for private forest enterprise. More than any other single factor it is accountable for the widening industry interest in the possibilities of Tree Farms.

Much has been said about the phenomenal possibilities in wood utilization. I am told that American Forest Products Industries, an organization which has the closest approach to a nation-wide spokesmanship for industrial forest uses, has prepared a group of more than 250 wood research projects, believed to be of sufficient present promise to justify exploration by the industries themselves. These researches, if undertaken, would go extensively not only into the mechanical and physical uses of wood but into wood chemical derivatives, wood treatments, cheap wood plastics, and the mysteries of lignin. The President of American Forest Products Industries is quoted in the press as having stated that the potential post-war development of these industries depends on two factors. First, coordination between all elements of these industries, and second, "unremitting research aimed at improving present products and in developing new ones." As an interested and somewhat informed observer, I would echo his enthusiasm for an important forestry objective.

In Virginia where I have operated a large farm for nearly ten years, hybrid corn has almost literally transformed the face of agriculture. Ten years ago in Louden County where I lived, hybrid corn was not only a novelty but a mystery. The corn crop averaged about twenty-five bushels to the acre. Today, hybrid corn has captured northern Virginia, and the average acre yield is more than forty bushels. On my own farm, we have at times exceeded one hundred bushels which is not phenomenal but better at least than twenty-five. The

same ideas of hybridizing and growing stock improvement through the various genetics arts, are being widely applied. They are being more widely explored on an experimental basis in forestry largely, I believe, by the U. S. Forest Service. Their possibilities in forest industrial usage should be more widely considered. This may turn out to be the best way of making two trees grow where one grew before and making both trees more resistant to deterioration.

In Georgia some years ago lived and worked a chemist known to many of you in person and to all of you, I think, by his distinguished name, Charles H. Herty. He was slight, soft-spoken, and modest and a great companion. Often I have sat on the end of the same log with him. He had faith in southern pine. The researches of his little laboratory in Savannah exploring the pulping possibilities of pitch-ridden southern pine provided much of the imagination back of the gigantic development in recent years of the pulp and paper industries in the South.

Potentially, there are, I think, even greater future possibilities in the Pacific Northwest. Much of its growing land is useful only for growing trees. The progress in forest fire protection, tree farms, tax improvements, and forest genetics will pave the way. But the new era of forestry will come more, I think, from men who by their enthusiasm, their faith and their works will do for the Big Timber of the Pacific Northwest what men like Charles H. Herty did for the lowly Pine Tree of the South.

SOCIAL IMPLICATIONS OF FORESTRY IN THE INLAND EMPIRE

BAKER BROWNELL

Director of The Montana Study[1]

I.

In the old days North Dakota was heavily forested, you will remember, and Paul Bunyan cleared it off in four weeks. He split the lumber into matches for the Swedish army, according to his contract, and then, because the King needed North Dakota for a Swedish kingdom, Paul did something that no lumberman up to that time had done: He removed the stumps. It was not a simple matter to remove them, but Paul met the emergency in his usual, original way. It seems that Babe, the blue ox, did not like to get his feet wet. So Paul Bunyan and his men got out the hose and flooded North Dakota with three feet of water. Then Babe was turned loose. The big ox roamed all over the state, stepping on the stumps to keep his feet out of water. So heavy was he that he drove each stump six feet into the ground. And thus North Dakota was made ready for the Swedish farmers.

Paul Bunyan is a symbol or prototype of American lumbering. His contract did require him to burn the brush and remove the stumps from North Dakota, but that, I believe, is the only instance in his long history of lumbering-off the continent where he concerned himself with the crucial problems of land-use and social stability that followed his axemen from Maine to Oregon. And his solution of them, even in North Dakota, I think you will agree, could have been better. Though Paul was likeable and hearty and could get out the timber in a big way, he was really a wrecker. He ranged across America like a fire destroying the forests. And though the lumber was marketed it did not change the fact that he left behind him wastelands of eroded, useless soil, dead rivers and rotting communities. Only once did Paul Bunyan meet his match in felling timber. That was when he encountered the great fire in the Bitterroots. Paul retired after that. It is said that he now devotes himself to hunting and fishing. I hope he obeys the game laws.

If Paul had attended a good school of forestry in his youth he might have turned out different. I do not know. In any case the Paul Bunyan era of lumbering in the United States is over. Or if not, it ought to be. We have learned, I hope, that we cannot leave our forestry policy to him.

As we look back at the Bunyan era of forestry it is not difficult to make fundamental criticisms. First, he killed the land. Where he passed, the land stopped producing. The forests in effect stopped growing. The character of the watershed disintegrated. The soil as forest, farm or grazing land failed. He laid his axe into the roots of our sustained economy. He gathered one harvest, the virgin timber, and left the place blasted thereafter. If ever the land was brought into production at all, the cost was borne by his successors, and a terrible cost it was. I refer, of course, not to the homestead settlers of the Midwest, but to the commercial lumbering that swept across the Lake States, through the South and over the forested regions of the West.

Second: Where Paul Bunyan passed, the human communities were left to die. Their development became virtually impossible and the ghosts of dead towns now haunt America. For one town like Elma, Washington, which somehow saves itself from extinction, there are hundreds of lumber towns dead or dying all over the United States. High among the social problem areas of America are

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[1]A three-year research project financed initially by the Humanities Division of one of the great foundations and sponsored by the state university system of Montana. Mr. Brownell is on leave from Northwestern University, where he is a Professor of Philosophy.

the cut-over lands of the Lake States, of the South, of Northern New England, and of various districts in the West such as Ravalli County, Montana, or cut-over counties in Washington and Oregon. In these regions relief rates usually are high and literacy is low, children go unfed and deficiency diseases flourish. In some of them whole populations are stranded, unable to get out, unable to live where they are. In other regions there is depopulation. More than three-fourths of the counties in the Great Lakes cut-over region are losing population. In the Pacific Coast States 25 per cent of the counties are being depopulated. In the Mountain States 53 per cent are being depopulated. Of the 3072 counties in the entire United States more than 82 per cent are losing rural population and more than 51 per cent are being depopulated, according to a study made in 1939 by Lively and Tauber. Much of this depopulation with its attendant economic waste, capital loss, migratory labor, low wages, disease, social disintegration and general decay is due to Paul Bunyan and his followers. He had a big time roaring around in the woods, but he left an unholy mess for the rest of us to clean up.

I will grant that Paul may be just a big, thoughtless boy at heart and did not know all the misery and disaster he was causing. I will grant too that the needs for rapid exploitation of resources may have seemed to outweigh sometimes the requirements of sustained welfare in social and economic life. But I will not grant that these apologies are valid now. We know better now. The United States Forest Service and other social minded folk have known better for a long time. These social implications of forestry have become, indeed, one of the foremost concerns of progressive foresters and lumbermen. They are problems that cannot be any longer ignored.

II.

Lincoln County, in the northwest corner of Montana, is the scene of a current project in the social implications of forestry. In cooperation with the United States Forest Service, the Montana Study began here last summer an exploratory research into social conditions bearing on the problems of community enrichment and stability. This was done for the purpose of working out a suitable social and community policy in connection with the proposed sustained yield program of forestry in the county. It is the first experiment of this kind. It should be of value not only in Lincoln County but elsewhere in connection with sustained yield programs, under Public Law 275.

The project was organized by A. G. Lindh, Assistant Forester, Region No. 1, and myself. The Montana Study supplied the man power, directed the project and will receive the report when it is finished. The Forest Service financed the project and gave invaluable counsel and factual information. The purpose of this joint arrangement with the direction and control left entirely with the Montana Study was to assure independence in making a report that might well be critical of some of the agencies and interests involved in the Lincoln County situation, including the Forest Service. The Montana Study, I perhaps should add, is a research program in the humanities, financed initially by the Rockefeller Foundation, and sponsored by the university system of the State of Montana. Its purpose is to study ways to improve the quality of living in the State of Montana and to make rural life attractive enough to hold more youths of high grade in the region where they were born. It is set up as an independent project. No agencies or institutions control its findings.

Our directive to Dr. and Mrs. Harold Kaufman, when they arrived in Lincoln County for fourteen weeks of field work on the project, was (1) get the relevant facts as to the social situation and social attitudes, and (2) in view of these facts make recommendations as to what social policies will help most to bring about a rich and stable community life in the county under the conditions of the sustained yield program. This directive leaves to Dr. and Mrs. Kaufman the main burden of this particular job, both as to fact finding and policy recommendation. They are young

sociologists, trained at Cornell, with experience in the Ozarks with rural and forest communities. In Lincoln County they very soon identified themselves with the communities of Libby and Troy, making clear that they were independent of both the Forest Service and J. Neils Lumber Company. This of course is precisely the approach that The Montana Study desired.

Their job was to study this active lumber region, not yet cut-over, but not without a history of booms and declines, and to find out so far as possible how community life could be made stable and worth while. It was a study designed to prevent ghost towns, a plan for a sustained yield program in human and social life coordinated with the sustained yield program in the material and economic field of the forestry service.

Lincoln County has the only remaining large stand of timber in Montana. Of its 2⅓ million acres 97 per cent are forested. Of the 7½ billion board feet of saw timber in the county, about ⅔ are in National Forest and ⅓ private. The population of Lincoln County is about 8000 and is less by about 10 per cent than what it was 20 years ago. Farms, mines and the railroad contributed altogether in 1939 about 3/10 of the basic income; relief money contributed about 1/10, and the forest industry contributed about 6/10 of the county's income. The total annual cash income of the 8000 people in the county averaged before the war about two million dollars, or roughly $250.00 per person.

Although the county is outwardly peaceful and fairly busy, it can easily be inferred from these facts that underneath there is considerable social tension, instability and even some conflict. Three main centers of influence are predominant in the county: First, the Forest Service; second, two or three large private concerns of which a lumber firm, the J. Neils Company, is the most active; third, the community, including some organized labor, a few farmers, some small contractors and small lumbermen called gyppos and other unorganized groups. Troy, one of the two larger towns, is definitely declining. Libby, the county seat, with the one large, operating sawmill, is at present prosperous.

The J. Neils Lumber Company is progressive and well managed. The owner family lives in Libby at the center of the company business. The company cooperates with the Forest Service, and contracts with the Forest Service are now under consideration which may give Lincoln County within a year one of the first, or possibly the first, sustained yield program in the United States. The company also owns or controls many of the main facilities and services of Libby; the bank and the power plant, for example, are generally considered by the community to be under the control of, if not the property of the company.[1] At least one reason for this is that there seems to be no other way in the present set-up whereby the town can have the bank or the power plant. The result, of course, is that economic, industrial and social power in the town and county are increasingly concentrated in one family. By the very nature of things and in spite of the good will of the Neils family, the town has difficulty in operating as a truly self-governing, cooperative community. Under the surface there is a good deal of tension, griping and feeling of insecurity both in Libby and in the county. This criticism comes for the most part from persons in declining communities, such as Troy, who feel that neither the Company nor the Forest Service is sufficiently considering their interests; from some labor groups, and more intensely from the gyppos, or small lumber contractors who feel that they are being squeezed out.

The Forest Service, on its part, has the difficult job of setting up a program that, on the one hand, is efficient in terms of management, money and materials, and, on the other, conducive to

[1] I am informed that this statement is misleading, that the Neils own only fifteen per cent of the stock of the bank, though W. Neils and two other company men are among the six directors, that the power company in Libby is owned by the Mountain States Power company, which buys power from the Neils power plant because it is cheaper, and that the power company in Troy is owned by the Neils, who have reduced the rates.

confident, secure living and community welfare. Both of these objectives, let me point out, involve the rejection of the Paul Bunyan policy of rape and wreck. In both are sought the conservation of land and timber, sustained production and the greatest long time service to the people of the United States, as well as the development of community life and human values in the area. The difficulty is in coordinating these values, and preventing emphasis on one from destroying the other. In working out a program involving this difficult adjustment of values the Forest Service naturally runs into criticism. How much of it is justified, I do not know, but I am sure that all of it is natural enough under the circumstances. This criticism of the Forest Service is not great in volume but comes from all sides.

The communities in Lincoln County are not developed or matured. Lumbering communities traditionally are fluid, insecure, subject to extreme ups and downs. Until recently the woods worker was on a seasonal job that paid him annually around $500.00 to $800.00. He was on the bum for the rest of the year, or a flop house resident on Trent Avenue, Spokane, or West Madison Street, Chicago. This is not now true of Lincoln County, but vestiges of the tradition remain. Libby is not a smart or snappy town, as compared for example with its neighbor, Bonner's Ferry. Though there is little in the broken sidewalks, mediocre restaurants and hotel, unattractive stores, to indicate community spirit or cooperative endeavor, there are numerous well kept lawns and neat little houses of individual residents. Some community services Libby and Lincoln County do have. A fine new court house, the famous Wrangler's Club, an excellent county library, the fourth in Montana, are examples.

These three, the J. Neils Lumber Company, the Forest Service, and the Community, are the main centers of influence in the county. To recommend a satisfactory set of relationships among the three, which will recognize both the human and the material interests involved, became the chief objective of our project. It is of course a preliminary, exploratory project. Its recommendations at best must be tentative. Certain suggestions, however, are worth consideration. These in general are of two kinds: One kind of recommendation has to do with policies and procedures on the part of the Forest Service or the Neils Company which may have both social and technical value. Another kind of recommendation has to do with community procedures and organization which may lead to greater stability in communities and a more worthwhile life.

An example of the first line of approach is the question of roads. Should the Forest Service build a system of roads in the county? These roads would be designed to tap lumber and recreational areas and serve both the public and lumbermen for an indefinite period. With such roads timber areas could be opened to the small operator who cannot now afford to build roads of his own. Roads constructed under Forest Service supervision, furthermore, could be made less a hazard in respect to hillside erosion, fire, fouling the streams and destroying the soil. They could give access to recreational areas, and with well designed recreational housing, cabins and the like, they could encourage tourist trade. They could encourage diversified industry and part-time farms. Such roads, again, might well make unnecessary many and perhaps most lumber camps. Lumber workers might commute in trucks from their homes in town. This in turn might have an important stabilizing effect on community and family life in the region. And the savings in camp costs would help considerably on the cost of the roads. Such a policy by the Forest Service in respect to roads alone would have far-reaching effect both socially and economically. A wise decision in respect to them would necessarily take into account many and variegated aspects of the situation. Policy decisions of this sort can be a most important factor in the social character and stability of the region.

Some examples of the second, or community, line of approach, are: (1) Community study groups and planning coun-

cils. These are an excellent integrative device so long as the groups are really representative of the entire community and have leaders with initiative and some experience. The Montana Study has had excellent results with study groups in other counties.

(2) A public advisory committee on forest policy. This can go far towards building community morale by giving the citizens a part in the discussion of decisions that will affect their welfare and happiness.

(3) Consideration by the community of possible cooperative projects. This may lead to developments that neither private capital nor public money can well undertake. In this way the bank or even the power plant might conceivably be acquired by the community.

(4) The diversification of industry and manufacturing. This has great possibilities, if careful studies are made of regional resources, power, markets and transportation. Much of this diversification can be in the direction of small industries, or services, for local markets. In some cases small industries, such as vermiculite mining at Libby can be developed for a national market. Wild huckleberries and Christmas trees are other examples.

(5) The expansion of tourist trade, recreation, wild life. Lincoln County has some of the finest resources in the world in this field. Their development will depend, among other things, on roads, tasteful and comfortable accommodations, intelligent guide services. With a new hotel or so, good tourist camps and other civic improvements Libby and Troy themselves could becomea ttractive tourist and travel centers. Troy especially, with probably the finest hunting and fishing in the Northwest, could become a national sportsman's resort.

Completion of Highway Number 2, the northernmost national road, seems assured within the next two or three years. This is probably the most beautiful of all our east-west highways, and no part of it is more beautiful than that in Lincoln County. Rich opportunities will confront the county for the careful planning of this great resource. Without planning the usual disastrous consequences will almost certainly ensue. There will be initial over-investment in hideous, uncomfortable tourist cabins set in the usual periphery of slums and junk piles about the approaches of each town. When the tourists have lodged for a year or so amid the shacks and billboards of these jerry-built recreational districts they will leave and many investors will go broke. Without intelligent planning there will be not only over-investment in poor recreational facilities, according to A. G. Lindh, but under-investment in good ones. Well located and attractive accommodations suited to the forest environment, cabins along a lake shore or among the trees on a promontory, expressing the cleanness, the beauty and the silence of the mountains, are accommodations that tourists in the long run will seek and pay for. Without recreational planning this over-investment in bad accommodations and under-investment in good ones will combine to kill the tourist business.

(6) The development of part-time farming and the encouragement of home gardens and livestock. This should have a far larger part in the life and economy of the small community than it now has. Diet can be greatly improved, income increased and greater security assured, if the homestead itself is made more productive. The family and children become far more functional, productive and thus more stable. There is no excuse, for example, for a milk famine in Libby when many, if not most, of the resident families could well keep goats or a cow.

(7) Encouragement of a community band, orchestra, chorus, drama group, craft work shop, sports, and other forms of native expression. These are particularly important in making the community attractive to young people and to others who remain young in spirit. Coaching and leadership are usually necessary for such expressive work. The state and local educational system should be urged to assist.

(8) A clean-up and paint-up cam-

paign. Without great cost, the towns in Lincoln County could be made far more attractive than they are. Salmon City, Idaho, for example, is a little town without great natural advantages. Its streets, however, are neat and glistening clean. Its grass and shrubbery are well tended. There are none of the shacks, junk piles and general disorder that make many an American town a good place to leave.

These are a few of the many possible lines of approach to community enrichment and stability in a foreign region. Alone they may not amount to much. If they can be coordinated, however, with wise and friendly policy directives on the part of the Forest Service and the J. Neils Company, there is every probability that the region may become a happy and secure place to live. Under the sustained yield program this probably will be done. If men will do their part as well as Nature so magnificently has done hers, there need be no doubt about Lincoln County.

III.

I have sketched briefly one promising attempt to build a new comprehensive policy for forestry in relation to community life. Its objective is to treat forest use and forest growth, lumbering, milling, and wholesome community life as inseparable parts of the same problem. This, strange as it may seem, has never been done before as a general, operational policy. It is the answer that progressive lumber men and the United States Forest Service make to the disasters that Paul Bunyan brings upon us. The work has been exploratory and is far from finished. When the report comes in, we can study it more carefully, but the final test will be operational.

Behind my description of this project are certain questions and dilemmas that have not been answered. Perhaps they cannot be answered. Do the American people intend to maintain the small community and family pattern of life that has been so important in our democratic tradition? It is easy for us to make pious affirmations about the small community and family, and many Americans do, but the fact remains that the small communities in America are distintegrating. They are draining away under the erosive influences of urban ways and mass industrial methods, and many of us are furthering that drainage far more than we are preventing it.

The family, as a significant, functional unit is declining. Wives and children more and more become economic liabilities. Production is limited more and more to one wage or salary earner who can in general attain economic security and comfort more easily without family obligations than with them. It is noteworthy that in those groups which profit most by the modern industrial and urban system, the reproduction rates are the lowest. The great city as a whole does not nearly reproduce itself. Within the urban economy the business and professional groups are far below the reproduction rate necessary to maintain themselves. It is statistically probable, for example, that the families of the people in this room will be extinct in a hundred years. By the same token the owners of commercial farms of good, black land are low on the reproductive side. In general in America only the poorest soil and the poorest people produce enough children to maintain the country's population. The landless farm workers, the share-croppers and tenants, the subsistence farmers of the southern mountains, from these who do not have the wealth or privileges of the modern urban system, will come the America of the future.

But crude population is not the only problem involved in the decline of the family and the small communities; I do not wish to appeal only to your loins. The disintegration of the community brings with it the disintegration of moral and social standards. It is no accident that the crime rates, insanity rates, suicide rates, death rates, are far higher in urban than in rural regions. Our democratic way of life has been fostered in small, neighborhood communities and will survive only in them. I am told by some that these are extreme statements. The problem of the survival of the small community is so critical, however, that I for one believe it is time for extreme statements.

Considerations such as these give emphasis to the attempt on the part of The Montana Study and the United States Forest Service to explore the possibilities of enriching and stabilizing the small forest community in relation to the sustained yield program. Lumbering has long been industrialized. It has gone through, I hope, the Paul Bunyan era of "cut out and get out." Today, in Lincoln County at least, it is trying to find ways to be socially responsible.

Many land-use industries have not gone through this cycle. Some agricultural practices are just now being industrialized. Industrial method, in contrast to agricultural and craft practices, rarely assimilates the worker. He gets his wages, but his family and community life have no part in the job. Industrial processes often require a mobile labor supply, involving a pool of surplus labor with chronic unemployment, in order to meet peak demands. This is particularly the case in the industrialization of products of the land. There is an increasing tendency to use fewer resident farmers and more wage labor of the seasonal, migratory kind. Once this was characteristic of the lumber industry and the wheat harvest; now it is extending to other products of the land. It is not conducive to a secure family life or a stable community. It is an anti-social tendency that in some regions is on the way to capture agriculture. With industrialization in fruit growing, in beets, in truck, in cotton, has come a broken, tattered army of millions of migratory farm laborers, more millions of share-croppers and nomadic tenants, broken communities, degraded families, illiterate, ill-fed, overworked children.

What the lumber industry and the Forest Service can do in coordinating sound community life with modern forestry and lumbering practice may help America to salvage its small communities in other fields. It may help us to cut short the degrading course of migrant agricultural armies, wandering homeless, voteless, voiceless over the face of the land.

THE SPECIFIC FORESTRY CASE FOR FLATHEAD COUNTY, MONTANA

GEORGE SUNDBORG

Industrial Analyst, Bonneville Power Administration

For several years a small staff in the Market Analysis Section of the Bonneville Power Administration has been putting the counties of the Pacific Northwest under the microscope. The object has been to determine present and future markets for electric power. Obviously this type of information is indispensable in planning the work of an agency selling power from facilities in which the people of the United States have invested more than $325 million. We have also found that people in each of the counties—businessmen, farmers, and others—can use the material we assemble to good advantage in promoting development of local resources and expanding local employment.

Our approach has been to take an over-all look at the economy of each county, with emphasis on the outlook for jobs and income, the principal influences on power markets. We realize as well as anyone that the county is not always or even often the ideal economic unit, but it has proved to be a practical working unit for our purposes, since the necessary statistics usually are available on a county basis, and we have been able to proceed with a fair degree of success in getting the answers we seek.

Up to the present time we have published reports covering 18 counties, seven of them in Oregon, nine in Washington, and two in Montana. Work is under way in 18 more counties, ten in Oregon, six in Washington, and two more in Montana. I am here today to talk briefly about the forest industries section of one of the surveys most recently issued, that for Flathead County, Montana. A number of copies of the Flathead report, entitled "The Economic Base for Power Markets in Flathead County, Montana," have been made available here today for those in attendance who may be interested.

We have no pretensions as foresters. But inevitably forest problems are involved in any survey of the economic possibilities of sections of the Pacific Northwest. They are involved in a very important way in a county such as this one in western Montana where almost nine-tenths of the area is classified as forest land and where about 15 percent of the working population finds employment in the forest industries.

Putting all of our information for Flathead County together we think we can see possibilities to increase employment from the 7,000 which it was in 1940 to more than 11,000 by 1955. We think it is within the realms of good possibility and sound judgment to expect an increase in county population from the present 22-25,000 to nearly 40,000 within the next ten years. The forest industries, already so important a part of the economy of this area, would under such conditions provide an even larger share of total employment and income. From less than 1,000 jobs at the present time the forests would be called upon to give employment to 2,000. Among the basic industries of the area, the forest industries would be called upon to make the greatest advance as providers of jobs and income.

Can it be done? Our analysis indicates it can be if the people want to make the effort. Flathead County is one of the fortunate few areas in the Pacific Northwest with remaining forest resources which can "take it." Cutting has not yet quite reached the level of replacement, and an increase in cutting is permissible within the limits of allowable annual forest drain on a sustained yield basis. Here a big "IF" has to be inserted. A greater drain upon the forest re-

sources of this county can be sustained forever—if enlightened cutting practices prevail, and if they prevail pretty generally over the whole workable forest area and pretty generally across all the available species.

I mentioned that almost nine-tenths of the land area of Flathead County is forest land. Of this, more than half is classified as commercial forest land; that is, it is capable of producing commercial timber, is economically accessible, and is not reserved from cutting. The commercial timber volume was estimated in 1940 to be nearly 8 billion board feet, of which less than 7 percent was in pole, seedling, and sapling stands, the rest being in saw-timber stands. Except for neighboring Lincoln County, which contains a little over 9 billion feet, this is more timber than exists in any other county in Montana.

The greatest part of the forest consists of old-growth timber, much of it mature and ready for cutting. In 1940 timber more than 120 years old predominated on fully one-half of the total commercial acreage, and on one-third of the acreage the timber was more than 200 years old. Growing forests currently are aiding an increment of 11 million cubic feet or 41 million board feet a year. Average annual 1935-40 cutting and fire drain was 16 million cubic feet. In other words, for every two cubic feet of timber being added by growth, three were being cut down or burned during that period. Since 1940 the county has been harvesting timber at about double the rate it is growing.

It should be borne in mind, however, that growth is not a reliable index to allowable cut in areas such as this where so large a proportion of the forest consists of decadent or nongrowing stands. In ripe, fully mature, old-growth timber there is not net growth. Growing saw-timber stands total only 165,000 acres out of a gross saw-timber area of 760,000 acres in Flathead County. Thus, while the current annual growth amounts to 127 board feet per acre of stands actually showing net growth, when apportioned over the entire saw-timber area, in most of which growth is at a standstill, the average growth annually amounts to only 27 board feet per acre. Cutting of the proper kind is the surest and quickest way to obtain net growth.

As to the quantity of timber which may be cut annually in the county in the future, this depends, as has been mentioned, on just how and where the cut takes place. An estimate has been worked out, assuming virtual clear cutting as in the past, adequate regeneration of cut-over areas within 20 years, utilization at current intensity, and an operable area amounting to about two-thirds of the total nonreserved commercial forest land contributing to the cut during a first transition period of, say, 100 years. This calculation shows an allowable annual all-species drain in Flathead County of 85 million board feet, log scale. This compares with an annual cutting rate of 79 million feet in the period 1935-40 and one of about 110 million feet in the period 1941-43.

If cutting is concentrated in only a portion of the operable area, for instance if cutting and recutting occur in only the most accessible areas before the stands reach maturity, and if no adequate measures are adopted to assure reforestation and protection of growing stands, the allowable drain will be materially less, probably only about half as much, or from 40 to 45 million feet a year.

If, on the other hand, the initial cutting is limited to the decadent elements of decadent stands and release cutting in young stands, leaving in all cases from 30 to 50 percent of the volume of thriftiest trees for succeeding cuts, the permissable annual drain could be 50 percent greater, or as much as 125 million feet.

In other words—and this is something we try to point up strongly in our survey—it is the choice of the logging operators and the people of the county, in the aggressiveness with which they adopt, or influence the adoption of, sustained-yield management and enlightened cutting practices, whether logging and sawmilling activity can con-

tinue forever at a rate above that of 1941-43 or whether it must be drastically curtailed 25 to 50 years hence because the best timber was cut not wisely but too well.

Of course, the problem is not quite so simple as I might make it appear here in this briefed discussion of a section which runs to many pages in the actual Flathead County report. There are complications in the differing philosophies of the various ownerships involved; there are inherent and ever-present difficulties in getting a dozen separate operators together on a rational policy. Under our American free enterprise system we should not blame operators for thinking of the problem from the standpoint of effect upon their own pocketbooks. But we can point out what might be desirable, from the standpoint of the community and its people, and this we try to do. We can say with truth in our Flathead County survey for instance, that the long-time trend of employment in the forest industries right there, in that county, threatens to be downward if exploitative cutting practices on private forest lands continue. We can point out, and we do, that in the national and state forests, methods of cutting have been adjusted toward insuring full potential crop replacement of the most desirable species for a second cut within a reasonable time.

In the Flathead—fortunately or unfortunately, depending upon point of view—only about one-third of the commercial forest land and one-third of the saw-timber volume are in private ownership, although the quality and "operability" of this timber is high. For instance in 1940 some 80 percent of ponderosa pine stands were in private holdings. The Federal Government owns 58 percent of commercial forest land and 55 per cent of saw-timber volume, chiefly in the Flathead National Forest, which is the third largest in the United States.

Some idea of the potential threat to forest industry payrolls can be gained by taking a close look at what has been happening to the western white pine and ponderosa pine resources of the area. These are the species which have been most in demand. Their logging has, in many cases, made possible the logging of other less valuable species in the same stands. When the operable pines are gone, or reduced to the point where they cannot be logged economically, it will be even less economic than at present to cut the less valuable larch, Douglas-fir, and spruce. In the period 1935-40 the pines were being logged at a rate of about 18.5 million feet a year in excess of the amount added by growth. Logging of these species, in the face of heavy wartime demand, had increased by 1943 to about double the 1935-40 rate. All ponderosa pine and western white pine timber of sawlog size would be logged off in about 30 years if this pressure on the species should continue. Forest resources available in other species still are substantial. Assuming orderly cutting methods, there is enough larch to last 100 years at the 1941-43 rate of logging, enough Douglas-fir to last 125 years, and enough spruce for more than 1,000 years.

One of the main problems in sustaining logging and lumbering payrolls at a high level is seen to be the finding of uses for species which have not been in great demand in the past. Unless these species become marketable, a decline in logging and lumbering employment is inevitable. Except as at present when market conditions are particularly favorable, the lumber industry in this area generally has been unable to utilize some of the more abundant species at a profit. It is in the position the livestock and meat packing industry would be if it could sell only steaks and roasts of grade AA meat. The logging industry needs to reduce relatively the cut of ponderosa pine and increase that of spruce, lodgepole pine, the balsam firs, and cottonwood if it is to make the fullest use of available resources.

In this section of Montana, as you probably know, the Christmas tree is a big business proposition. About one-fifth of the nation's Christmas trees come from this area. Since 1941 an average of slightly more than a million Christmas trees a year have been shipped from Flathead County. In the

large-scale harvesting of small evergreens for Christmas trees, there is an inherent threat to the development of mature forest stands required for other purposes. Unfortunately, too much of the cutting on private land has been on a liquidation basis, with few owners cutting in such a way as to regenerate to Christmas trees. Such practices cannot continue without doing irreparable harm to the county's future forest resources. But there is a bright side to this picture too. Only a small portion of the potential Christmas tree area in the county has been worked. If operations are spread out so that undue pressure is removed from some of the more accessible areas, there is no reason why the cropping of Christmas trees should not continue permanently at about the current rate, while still leaving the forests to produce big trees for higher uses.

Even more important from the standpoint of employment outlook than the question of how many trees can be cut is the matter of what is done with them between the time they hit the ground and the time they leave the county. The forest products industry in this area has not progressed very far beyond the stage of producing basic products only. No furniture, plywood, pulp or paper is manufactured in the county.

While logging in 1940 employed 283 workers and sawmills 572, only 22 persons were employed in woodworking industries outside the sawmills. We found that some of the timber products of the county did not even go through the sawmills. Among these are small quantities of cedar posts, cedar poles, piling, hewed ties, mine timbers, and fence poles. In addition about 10,000 cords of pulpwood have been shipped from the county in each of the past few years, this material going in both directions, to pulp mills in Wisconsin and in northeastern Washington.

A good measure of the payroll contribution of a forest industry is the total of man-hours employed on a thousand feet of logs before these logs or their resultant product leave the locality. Logging furnishes about 8 man-hours per thousand. Sawing into lumber under current local practices provides about 12 man-hours more. Practically all of Flathead County's forest products manufacturing at the present time stops at this point, with lumber being exported with about 20 man-hours of work behind each thousand feet. If some of this lumber were remanufactured into sash and doors, 30 payroll hours would be added for each thousand board feet of logs put to this use. The manufacture of rough boxes would add about 24 hours of work to the lumber total. Making a higher quality container would provide from 50 to 60 man-hours of employment additional. Use of some of the suitable material for matches would require 140 new man-hours of employment per thousand feet of logs. Plywood calls for about 40 man-hours of labor beyond the log stage. It became obvious that there are real possibilities for increasing Flathead County payrolls by subjecting wood to more refined manufacturing processes before it leaves the locality.

We found, for instance, that most of the ponderosa pine now being cut at so high a rate in the county is being shipped as lumber to such Middle West centers as Des Moines, Iowa, for remanufacture into sash and doors. This process could be conducted locally. There is enough ponderosa pine remaining to furnish a good-sized sash and door plant with materials indefinitely. A plant employing between 100 and 150 could be supported on such a cut. A small but valuable market for box manufacturing is provided by the sweet cherry crop of Flathead and Lake Counties, and this is an opportunity uncovered in our survey. Because we look at the econmy of the area as a whole, we are able to provide the prospective box manufacturer with an estimate of how many boxes will be required by the cherry crop of 1950 or 1955. An even better opportunity was found to exist for manufacturing special types of containers for butter, eggs, cheese, and similar products, for which tasteless, odorless boxes of white wood are required. Although packers in the Midwest have been using aspen, the Engelmann spruce and western cottonwood which grow in the Flathead re-

gion proved to be ideal for this purpose. In the course of time, it is hoped that one and possibly two small container plants employing from 30 to 40 men might be established in the county.

For the wood used in the little "strike-on-box" safety matches, the Engelmann spruce of Flathead County was found to have all the desirable properties—white color, long fiber, lightness, toughness, and structural capacity to take chemical dips which increase inflammability and prevent after-glow. These matches are now made by a veneer and chopping process in two large plants, one in Maine and one in Minnesota. A good-sized match plant in Montana would have a very modest raw material requirement. Only about 5 million feet of spruce a year would be needed for a factory employing 450 persons.

Both larch and ponderosa pine from this section have been shown by laboratory tests and trial factory production to be suitable for plywood manufacture. Even the peeler cores could find a market near at hand, for use as mine timbers or for toy and specialty stock. Local markets in Montana, Idaho, and Wyoming normally consume 20 million square feet of plywood annually, and in none of this area is there a plywood plant. We found that the peeler log supply tributary to logical manufacturing centers in northwestern Montana probably amounts to about 10 million feet of larch and at least half as much ponderosa pine which, while small in Douglas-fir plywood terms is sufficient to support two plants producing about 15 million square feet apiece. One such plant might well be located in the Flathead area.

The fairly large Engelmann spruce timber stands of the region suggest their use in pulp and paper manufacture. The outlook today for success of a pulp and paper venture in this area is probably the best it has ever been. The industry in some sections of the United States is right at the edge of the last frontier in resources. The middle western states of Minnesota, Wisconsin, Michigan, Illinois, Indiana, and Ohio had 206 paper mills operating in 1940. Some 150 of these purchase all their pulp and these are potential customers for bleached or unbleached sulphite pulp such as might well be produced in Montana. It is probable that a 100-ton pulp mill in this area would have to draw about half of its pulpwood from outside the county. Sufficient timber of the pulp species is available in the balance of northwestern Montana to more than make up the deficit. A very general estimate is that a thousand feet of logs furnishes 80 man-hours of employment in a pulp and paper mill. A pulp or pulp and paper plant presents good possibilities in addition for the integration of a number of minor wood-using industries with its main operation.

These are just a few of the forest products manufacturing possibilities which we examined in some detail in the course of our survey. There are many others discussed in the report, ranging from grain doors, ready-cut houses, toys and laminated trusses to Torula yeast, Pres-to-logs, wood flour, galactan and charcoal. Not all of them are feasible operations for this particular area perhaps, but in our survey we tried to find out just what the situation was in respect to each product. This led us to a study not only of raw material supply and industrial processes, but also of freight rates and markets. We feel this is the kind of analytical and objective study which must be made if the forest communities of the Pacific Northwest are to come into their own—and if we are going to develop the large peacetime power markets which we are confident can be based upon the natural resources of the Columbia basin.

In the foreword of the Flathead County survey acknowledgment is made to more than 100 individuals who have assisted in its preparation. These include in the forestry field men in the Federal and state agencies, in private industry associations and private operators. Naturally, in dealing in a comparatively brief time and space with problems as numerous and complex as those encountered in a survey of this type, we have had to call on the information, skill, and judgment of many men. We hope that from them—including many who are

here today—we continue to learn as we go, making each successive survey a little bit better than the one which preceded it.

I said we had no pretensions as foresters. I might better say we have no pretensions of any kind. Our contribution lies in our consideration of the forest industry—and of agriculture, mining, manufacturing, the tourist trade, service industry, and every other compartment of human endeavor—in its complete setting in the economy of an area. This, we feel, is one way the picture has to be viewed if we are going to make here in the Pacific Northwest substantial advance toward the common goal—a more secure and more rewarding life for all.

SOME OBSERVATIONS ON THE WEED FLORA OF WYOMING

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No fully satisfactory method has yet been devised for reporting the specific or relative concentrations of plant species over large areas. To date, two general methods of reporting plant distribution have been used. The taxonomic botanists have limited themselves largely to reporting the plants present in a given area or region. Range management workers have used the other method of reporting specific plant stands on small areas.

The procedure used in this study is quite different from the two preceding methods. The data reported here are based upon a survey of plant seeds or impurities found in approximately 1000 seed samples of the 1941 crop, submitted to the Wyoming State Seed Laboratory in 1941-42. It is therefore a study of the weeds found in the cultivated or cropped lands of Wyoming. This method has the disadvantage of being too conservative. About 50 per cent of the samples had been cleaned. The remaining 50 per cent had been partially cleaned, having passed through the threshing machine before they reached the laboratory. We therefore recognize that some of the species of weeds which appeared in the fields might possibly have been completely removed and lost before the samples were submitted for analysis. There is, however, satisfaction in knowing from the outset that the data gathered in a study will be conservative.

The study was started with the object of learning what impurities were more prevalent in the samples, that is—what were the more common weeds? Although the data are specific to the cultivated lands of Wyoming, we can be quite confident that if similar studies are made in other states similar conditions will be revealed.

Many have had the illusion that only our so-called noxious weeds are of great significance as a hazard to agriculture. Many professional and non-professional men alike, and more regretfully, some of our weed men both in enforcement and research, nurture this idea. We hear also, that we can cannot legitimately discuss the common weed problem because they cannot be defined or specified.

From the data gathered in this study we can observe some of the broader aspects of the weed problem. Some agreement can perhaps be reached in designating our more important field weeds. We will see that a real, common weed problem exists, and that the losses inflicted by these plants upon agriculture must be far in excess to the losses attributed to noxious weeds, because they exist in such great numbers and are so widespread. I am in no way attempting to minimize the devastation of our noxious weeds but want to emphasize a phase which has been neglected.

A little history is now in order. Wyoming came into statehood just before the turn of the century. Prior to that time, and for a time thereafter, it was exclusively a cattle and sheep country. Shortly after 1900, farming began to develop on both the dry and irrigated lands. Farming brought the introduction of crop seeds and with them came the weed seeds, which like the crop seeds, originated in the Old World.

The vegetation which supported the early livestock industry was exclusively native. This is still very largely true except in certain areas where various exotics have invaded. There is much concern in areas where *Bromus tectorum, Salsola pestifer* and others have invaded, and more recently the poisonous *Halogeton glomeratus*. In addition, there are local areas infested with our noxious *Lepidium draba, Convolvulus*

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arvensis, Centaurea repens and others. Fortunately, the major cover of the range still consists of the native grasses.

Our study was made to determine what weeds were persisting in the crop lands of that State. We must recall that these cropped lands had only a few years ago been covered with native vegetation. The questions to be answered were these: Were the weeds now persisting, of native or foreign origin? And more specifically, what was the relative distribution or intensity of native and introduced species as weeds?

For brevity in this paper only the species which appeared in two or more per cent of all samples are reported here. The 36 species listed are only about one-tenth of all that were found. The data do not show the degree to which the samples were infested. It instead shows the percentage of samples which were infested by a given weed. No discussion is given to the persistence or description of the plants as weeds. Some conclusions on persistence can be obtained from more detailed observation of the data in Table I since frequency is in direct relation to persistence.

Of the 36 species listed in Table I, 20 are of exotic origin while 16 are native. The 20 introduced species appeared 2,964 times as a total for all samples, while the 16 native species appeared 1,333 times. The ratio of introduced to native species was 1.2 to 1, while the frequency of occurrence of the seeds of introduced species as compared to native was in the ratio of 2.2 to 1. It therefore becomes apparent that our introduced weed species have spread faster and have excelled in their ability to maintain themselves through greater adversity than our native species. A number of the weeds found in this study to be very common and widespread are listed as "sparingly introduced" in the "New Manual of Rocky Mountain Botany" published in 1909. Four other species listed here are not recorded in that manual.

None of the widely recognized noxious weeds appear in Table I because they were so rarely present in seed samples.

Table I

Weed Seeds which Appeared in 2 or More Per Cent of All Seed Samples

Name of Weed	Per Cent of Samples Infested	Native or Introduced Species
Annuals		
Panicum capillare	9.4	N
Echinochloa crus galli	17.7	I
Setaria viridis	41.5	I
Avena fatua	6.5	I
Bromus commutatus	7.2	I
Bromus tectorum	13.1	I
Polygonum aviculare	11.4	N
Polygonum convolvulus	11.3	I
Chenopodium album	43.2	I
Atriplex species	13.5	N
Salsola pestifer	48.6	I
Kochia scoparia	20.2	I
Amaranthus blitoides	6.2	N
Amaranthus retroflexus	28.7	I
Thlaspi arvense	8.3	I
Erucastrum Pollichii	2.8	I
Lepidium apetalum	4.6	I
Conringia orientalis	3.7	I
Camelina microcarpa	3.4	I
Brassica arvensis	3.5	I
Brassica juncea	8.5	I
Brassica nigra	3.6	I
Cuscuta species	5.0	N
Lappula occidentalis	12.4	N
Salvia lanceolata	4.7	N
Plantago Purshii	5.2	N
Iva xanthifolia	4.6	N
Lactuca scariola	3.3	I
Helianthus annuus	26.3	N
Biennials		
Hordeum jubatum	5.2	N
Cirsium Flodmani	2.0	N
Perennials		
Stipa viridula	4.9	N
Oryzopsis hymenoides	4.3	N
Rumex crispus	16.7	I
Iva axillaris	5.3	N
Grindelia squarrosa	12.9	N

The survey showed these noxious weeds to be present in the following frequencies: *Cirsium arvense* .4%, *Convolvulus arvensis* .2%, *Lepidium draba* .2%, *Centaurea repens* .1%, and *Agropyron repens* .1%.

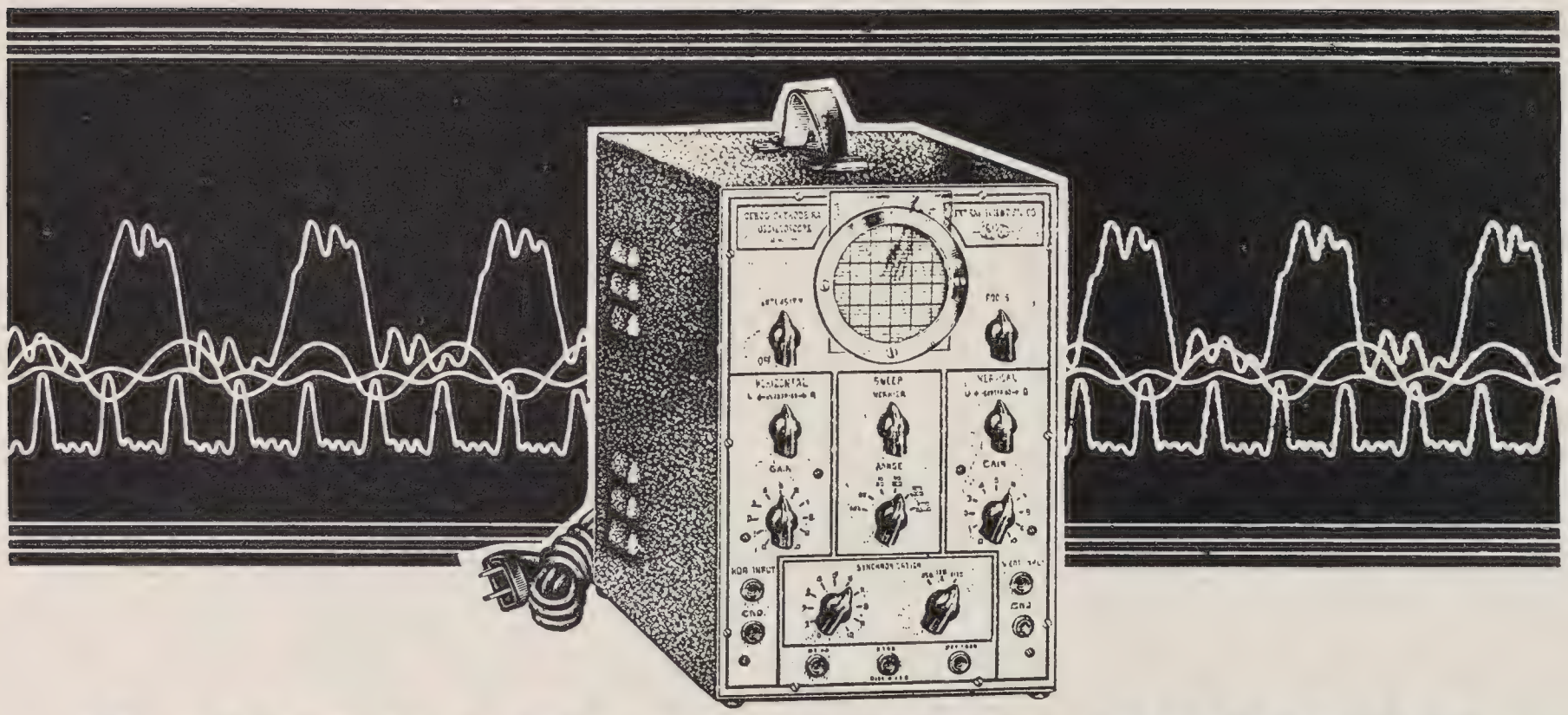
The frequency of these 36 common weed seeds shown in Table I, when compared to the frequency of noxious weed seeds was in the ratio of 429 to 1. Since noxious weeds are so much more destructive than common weeds on a plant for plant basis, this ratio is not a true relation of their importance. Their ratio on the basis of importance would be narrowed considerably.

The question: which are our common weeds, seems adequately answered. There can be no better evidence as to what constitutes weeds than to learn which ones are persisting and which ones have and are proving their tenacity.

The introduced species are our serious weeds today and are destined to become more exclusively the weeds of the future. Only by constant vigil, better cropping methods, and above all else, really clean seed, can we hope to even hold our own. Really clean seed means something more than staying within the maximum State tolerance of 1, 2, or 3% weed seed. We should instead strive for a weed seed limit of .1% in small seeded legumes, and .01% in the cereals.

The status of the weed distribution in Wyoming less than forty years after the virgin prairie was first plowed and seeded was briefly this: Every field was infested with weeds of both native and foreign origin, with the introduced weeds being represented by a larger number of species, and in greater abundance than the native. Noxious introduced weeds were infesting perhaps a hundred thousand acres but the common weeds were present on over 100 million acres.

This was the condition after 40 years. We might well ponder what the status will be when another 40 years have passed. These same, and much worse, conditions prevail throughout the western states. Therefore, the evidence and the problem presented is not limited to Wyoming but applies to every state in the region. It will require concerted effort on the part of every individual, community, and state to make any improvement of our present status. Without such concerted effort we will have to expect more weeds and, as a result, lower yields with each succeeding year.



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COMMERCIAL PRINTING DEPARTMENT

NORTHWEST SCIENCE

May, 1946

Vol. XX, No. 2

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SMITHSONIAN INSTITUTION
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NORTHWEST SCIENCE

Volume XX, Number 2

1946

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Published quarterly by the Northwest Scientific Association

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, one dollar per year; to non-members, one dollar. Single copies thirty cents each. Volumes I to XVII, 1927 to 1943, each $1.25. All sixteen volumes, $17.00.

Illustrations and tabular matter together should be limited to approximately twenty per cent of the total number of pages. Authors will be charged at cost rates for illustrations and tabular matter in excess of that amount (approximately $3.70 per page for tabular matter; $7.00 per page for line cuts; $5.00 to $6.00 per page for screen cuts).

NORTHWEST SCIENCE

VOL. XX, NO. 2 MAY, 1946

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To the Members of the Northwest Scientific Association:

At the annual business meeting on December 28, 1945, your president was instructed by Resolutions Nos. 2, 3, and 4 to appoint three committees as follows:

No. 2. "Resolved that a committee be named to consult with the editor of Northwest Science and to assist him in the appointment of associate editors in the various specialties and to collaborate in collecting, screening and editing papers for Northwest Science."

With the approval of Editor Hatch (1/25/46) I therefore appoint the eight Section chairman, Church, Davis, Diettert, Gross, Lundy, O'Leary, Schwendiman, and Tascher to serve as ASSOCIATE EDITORS during 1946. Editor Hatch will be chairman of this committee.

No. 3. "Resolved that a committee be named to encourage the participation of amateur scientists in the activities of the Northwest Scientific Association."

As this is clearly an activity in which all Sections should be interested, the eight Section chairmen are again appointed, to serve under the chairmanship of Father O'Leary, S.J. Specific recommendations will be expected from this committee at the 1946 annual meeting.

No. 4. "Resolved that a committee be named to consider the practicability of forming a north coast section of the Northwest Scientific Association."

For this purpose I appoint Dr. G. E. Goodspeed, chairman, Dr. E. C. McCulloch, and Dr. J. W. Severy. A recommendation of the Association will be expected at the 1946 annual meeting.

Copies of this notice have been sent to each of the chairmen named.

H. T. GISBORNE,

President.

COMMITTEE APPOINTMENT

RADAR-WEATHER COMMITTEE

Recently revealed information indicates that radar has been found useful for improving short-period weather forecasts by scanning the sky to determine the existence and imminence of precipitation and lightning. The need of such improvements in the Inland Empire, comprising eastern Washington, northern Idaho, and western Montana, are well known.

An exceptionally favorable opportunity for testing this new method in this region exists in the location, elevation, and topography surrounding Mt. Spokane. From this 5,800-foot point a sky-visibility of 150 to 200 miles is possible throughout the NW and SW quadrants, from which storms approach.

To examine the feasibility of such work, to inform the Northwest Scientific Association of its findings, and to take such further action as may be directed, a committee is hereby appointed. Mr. C. A. Wellner, of the Northern Rocky Mountain Forest and Range Experiment Station of Missoula, formerly an aerologist in the Navy, will serve as chairman. Prof. Phil E. Church, of the University of Washington, during the war a meteorologist for the Manhattan District Project, will assist. A report will be expected at the 1946 annual meeting of our Association.

H. T. GISBORNE,

President.

THE LIFE ZONE PROBLEM IN THE NORTHERN INTERMOUNTAIN REGION*

R. F. DAUBENMIRE[1]

A satisfactory basis for delimiting areas that are essentially uniform in biotic potentiality has long been sought by biologists, and many criteria have been employed for so classifying the land surface. Some investigators have used physiography, others climate, and still others the biotic patterns established by the distributions of species or communities.

Life zones have been based upon physiography chiefly when data were insufficient to construct a better system. This criterion has generally proven unsatisfactoriy upon detailed study, although the concept has some value as indicated by the sharp differences in vegetation on the west and east slopes of the continental divide in northern Montana, and on the two slopes of the Cascade Mountains in Washington and Oregon. Many examples could be cited, however, where physiographically different areas have similar biotas. The sagebrush-grass type of vegetation, though characteristic of the Great Basin, is by no means confined to that physiographically distinct region, but spreads into adjoining provinces in all directions.

An ecologically significant climatologic delimitation of natural areas still remains little more than an aspiration. On the one hand we possess but a fraction of the physiologic data necessary for evaluating climatic data satisfactorily in relation to biotic distribution; on the other, it appears increasingly more apparent that the climatic statistics collected to date are not very significant biologically. For these reasons, tremenduous expanses of country would long remain blank spaces on biogeographic maps if they had to await the accumulation of the proper climate data for their classification.

Another limitation to the use of climatic data is the fact that while climate is the most important force governing distribution on a large scale, the smaller the area under consideration the less its importance. An example may clarify this point. Douglas fir forests complete with characteristic undergrowth exist in the dry climate of the lower Clearwater River Valley where northerly slope exposure compensates for climatic dryness. Eastward in the mountains essentially the same plant assemblage extends 4,000 feet higher into a relatively cold and moist climate. At this upper extremity, however, it occurs only on south-facing slopes that are warm and subject to sufficient soil drouth to allow Douglas fir to exist free from competition with species more characteristic of the climate. In cases like this, biologists must concern themselves more with similarities in distribution of organisms than with the differences in macroclimates. Examples of non-climatic factors governing distribution are even more abundant in the animal kingdom.

The data of biotic distribution appear to provide the best approach to the problem of defining biogeographic areas (i.e., life zones, biotic provinces, or biomes). The biologic criterion is logically the most sound, for wherever there are significant changes in physiography or climate, these are reflected in the relative abundance and distribution of species. This is the best approach because it is the most direct.

*The term northern intermountain region is here used to designate the region between the divides of the Cascade Mountains and the Rocky Mountains, extending no farther south than approximately 45°N latitude. This geographic area has several highly distinctive features with respect to both flora and vegetation types. The region thus defined does not correspond with any of the physiographic provinces of Fenneman (1931). It includes all of the "Palousian Biotic Province" of Dice (1943) plus considerable forest land in the adjacent mountains.

[1] University of Idaho.

DEVELOPMENT OF THE LIFE ZONE CONCEPT

The first comprehensive study of Rocky Mountain ecology, which appeared more than half a century ago, was an attempt by C. H. Merriam to define life zones. Testifying to the need for information of this type and to the success of the initial study, the results of Merriam's work gained quick popularity and were subsequently used by many biologists. As investigation in the new science of ecology progressed, however, the inadequacy of Merriam's classification became more and more apparent. This naturally resulted in the need for a system of classification more in accord with the newer information. In the words of Livingston and Shreve (1921), "the system of life zones worked out by Merriam . . . will require much modification before it may become at all satisfactory to a serious student of etiologic plant geography." Animal ecologists as well have often come to the same conclusion (Shelford, 1932; Brecher, 1943; Kendeigh, 1932). The vegetation of the northern Rockies illustrates to good advantage some of the shortcomings of Merriam's system ,and a bit of history may clarify some of the above statements, as well as serve to introduce the alternative classification outlined later.

In his first paper on life zones of the Rockies, Merriam (1890) presented excellent descriptions of the vegetation zones and their accompanying faunas as he observed them in northern Arizona. Although the dynamic aspects of vegetation had not yet received much attention, Merriam happily avoided confusing seral and climax communities, so that his delimitations and descriptions of the the zones in Arizona are perfectly acceptable to modern ecologists. Few indeed, however, would now agree with the statement (p.37) that "the distribution of animals and plants depends primarily upon temperature." His acceptance of this hypothesis as a fact was later to prove disastrous.

Merriam's second field of study was the Salmon River Mountain region of central Idaho (Merriam, 1891), where he encountered a zonal pattern similar to that in Arizona. In this region, however, no ponderosa pine belt separates the Douglas fir and desert zones. Had he not been so strongly of the opinion that zones are controlled by the temperature gradient, he would have concluded simply that the ponderosa pine zone is absent from the Salmon River Mountains. But with zones delimited on a temperature basis, there could be no such thing as a zone missing from a sequence on a mountain slope! Merriam solved this dilemma by assigning the desert vegetation (sagebrush-grass zone) of southern Idaho to the same position in his classification that the ponderosa pine zone occupied in the southern Rockies. Had he extended his studies into the region north of the Salmon River he would have been faced with still another major problem. North of this drainage a new zone foreign to the central and southern Rockies is inserted between two zones which are contiguous in central Idaho and southward. This new zone, the arborvitae-hemlock zone, characteristically separates the Douglas fir and spruce-fir zones.

If there is any need of further demonstration that temperature alone is inadequate as a determinant of zone boundaries, and that climate involves much more than temperature data, the following circumstances may be added to the accumulated evidence. In that part of Idaho where the Columbia Plateau is dissected by the Clearwater River and its tributaries, forests extend to exceptionally low elevations down the valleys, whereas prairie extends quite high on the uplands. The weather data collected at Fenn Ranger Station at 488 m (1600 ft.) in the Selway Valley represent the arborvitae-hemlock zone. Those collected at Grangeville at 1039 m (3409 ft) on the adjoining plateau represent the fescue-wheatgrass type of prairie. It will be seen later that where topography does not permit such extreme interfingering of zones, this prairie is *the third zone below* the arborvitae-hemlock zone in the normal sequence. Re-

ferring to Figure 1 it is clear that the mean monthly temperatures of the prairie at Grangeville are all *lower* than those of the forest at Fenn. According to Merriam's scheme Fenn should not only be cooler than Grangeville, but be sufficiently cooler that at least one temperature zone could be delimited between these stations!

It seems clear that the most serious difficulty besetting Merriam's work resulted from shifting the basis of delimiting life zones from the *facts* of biotic distribution—the sole criterion of zones in the initial study—to two temperature hypotheses of his own contrivance, which were used in his later work (Miriam, 1898). Even now biologists have insufficient ecologic information for evaluating temperature in relation to distribution, and it seems clearly obvious that Merriam's temperature "laws" were as premature as they were unsupported by experimental evidence. Shelford (1929) has pointed out that Merrima's life zone system only considers "the supposed relations of animals and plants to one feature of climate, namely, temperature. It does not proceed to further analysis of the cause of the presence of the organism or . . . does not consider some organisms as important in the control of communities, and it has applied neither experimental methods of any kind nor quantitative field methods." Furthermore, most adherents to Merriam's hypothese have overlooked the fact that by his own admission (Merriam, 1899) every one of the calculations upon which he based the limits of his temperature zones is in error!

Merriam's steadfast adherence to his temperature hypotheses not only led to the inconsistency of classification just noted, but also resulted invariably in disharmony among those who have accepted his work without question and tried to apply the system in the field. The deliminations of zones used by subsequent biologists in the northern Rocky Mountain region illustrate this confusion (Table 1), and several important conclusions can be drawn from their comparison.

The systems in columns 1-3 of Table 1 are the classifications of those who have followed Merriam's scheme, and in each instance these authors expressed dissatisfaction with such life zones. Piper (1906, p. 34) stated that the determination of life zones is "more or less arbitrary." Standley (1921) concluded that life zones are usually not sharply marked, and although he follows tradition in recognizing a distinct "Hudsonian" zone, he remarks (p. 245) that he has never seen a region where it is well marked! St. John (1937), following Merriam via Piper, stated (p. ix) that "life zones do not seem to be scientific concepts capable of precise definition."

The classifications indicated in columns 6, 7, and 8 of Table 1 present several distinct contrasts to Merriam's system. First, these zone deliminations are based frankly upon the facts of biotic distribution, and no ability to define the same areas by climatic criteria is claimed. Second, the biologists who have used these systems* have expressed not the slightest doubt as to the value and distinctiveness of such zones. Differences among these three classifications involve no more than matters of terminology, and opinions concerning the desirability of lumping distinct entities for the purposes of classification.

A second major point brought out by Table 1 is the confused state of terminology, and the pressing need for uniformity (Odum, 1945). Because there has been considerable variation among the units to which the terms "montane," "Hudsonian," "Canadian," "Transition," and "Upper Sonoran" have been applied, and because these terms in themselves are wholly arbitrary and meaningless, they should be completely abandoned. "Subalpine" is likewise a poor term to apply specifically to any one unit, for subalpine vegetation differs considerably from one mountain system to another. The only terminology free from these criticisms is that based upon the dom-

*See also a paper by Slipp and Snell, 1944.

Table 1. Comparison of classifications of life zones of vari ous biologists working in the northern intermountain region.

1	2	3	4	5	6	7	8
Piper (1906)	St. John (1937)	Standley (1921)	(Davis) (1939)	Rydberg (1917)	Spilsbury & Tisdale (1944)	Weaver & Clements (1938)	Daubenmire*** (1942)
Arctic Zone	.....	Arctic-Alpine Zone	Northern Rocky Mountain Biotic Area	Alpine Zone	.....	Carex-Poa Association	Sedge-grass Zone
Hudsonian Zone	Hudsonian Zone*	Hudsonian Zone*		Subalpine Zone	Upper Subalpine Zone*	Picea-Abies Association	Spruce-Fir Zone
					Subalpine Zone		
Canadian Zone	Canadian Zone	Canadian Zone		Montane & Submontane Zones (not clearly defined)	.....	Thuja-Tsuga Association	Arborvitae-Hemlock Zone
					Montane Zone	Pinus-Pseudotsuga Association	Douglas Fir Zone
	Arid Transition Timbered Zone				Pine Savanna Zone		Ponderosa Pine Zone
Arid Transition Zone	Arid Transition Timberless Zone	Transition Zone**	Columbia Plateau Biotic Area	Plains	Upper Grassland Zone	Agropyron-Festuca Association	Fescue-Wheatgrass Zone
					Middle Grassland Zone		Wheatgrass-Bluegrass Zone
Upper Sonoran Zone	Upper Sonoran Zone	.....		Sonoran Zone	Lower Grassland Zone		Sagebrush-Grass Zone

*Includes only the ecotone between forest and tundra, where trees are dwarfed and do not form a continuous cover. Not considered a separate zone by others.

**Includes prairie types different ecologically and sociologically but cor responding in altitudinal position to those listed at far right.

***An adaptation of diverse classifications of earlier workers which, as a result of nine years of field work in the region, seems best to fit the vegetation.

inant and characteristic species of each zone, as columns 7 and 8 of Table 1. Obviously where wide geographic area is under consideration it would be necessary to specify "Engelmann spruce-subalpine fir" zone instead of simply "spruce-fir" zone.

THE BASIS OF A WORKABLE LIFE ZONE SYSTEM

As the foregoing discussion indicates, the writer believes that vegetation provides the most practical basis for life-zone classification. The reasons for this belief follow.

(1) In comparison with animals, plants are more closely governed by (and therefore better indices of) the physical forces of environment. In the words of an eminent animal ecologist, "in natural environments at least, animals are largely controlled by the plant communities in which they live. They are either directly dependent upon the plants for food, or they experience the physical conditions which are brought about by the reaction of a plant community" (Chapman, 1931, p. 224). It is well known that the destruction of vegetation causes a complete change of fauna in an area, and that plant succession controls the type of animals subsequently occupying the area, as well as the speed of their invasion.

(2) Animals frequently change their ranges within short time by expansion (coyote, prairie chicken), restrictions (wapiti, grizzly bear, black bear), or extinctions (passenger pigeon, heath hen, bison), whereas with the exception of exotic weeds, plant ranges remain fairly constant. A classification of the land surface into biotic zones would therefore need frequent revisions if based upon the distribution of the larger animals, yet the fundamental biologic potentialities would not change.

(3) The more common animals, to a greater extent than plants, often fail to inhabit all of the biogeographic area in which they are found. Jack rabbits and ground squirrels (*Citellus*), for example, occupy isolated segments of the sage-brush-grass type of vegetation, and the bison originally inhabited only a portion of the same area. On the other hand, such characteristic plant species as *Artemisia tridentata, Salvia carnosa, Sarcobatus vermiculatus, and Grayia spinosa,* and conspicuous genera as *Chrysothamnus, Agropyron,* and *Poa* are much more uniformly distributed throughout this area. Apparently competition as well as specific physical requirements may prevent ecologically equivalent animals from occupying the same territory, even though their total geographic ranges are similar (Davis, 1939). Competition, however, does not have the same segregating effect upon ecologically equivalent plants. In the arborvitae - hemlock and spruce - fir zones, for example, the two respective characteristic dominants compete intensely, yet they grow in close association. Therefore, because the larger plants are more likely to be regularly present when particular combinations of inorganic factors recur than are the larger animals, plants are the more valuable zone indicators.

(4) The ecologically significant plants are larger, more numerous per unit area, and are more susceptible to identification over longer periods of the year than are most animals. Thus, if a zone were based upon the presence of a kind of woodpecker, antelope, tree frog, or snake, one could tramp the field for hours without seeing a single zone indicator, and to determine the zonal status of a particular area might require days or weeks of observation there. Trees, especially seedlings, occur in hundreds per acre, and if set down in a strange region anyone thoroughly familiar with the few zonal criteria to be listed later could ordinarily identify the zone at practically any season and without moving from the spot. Because of migration or hibernation, many animals are conspicuous in any one zone for only a few months out of the year, whereas woody plants, which are usually good zone indicators, are readily perceivable and easily identified in the dormant condition.

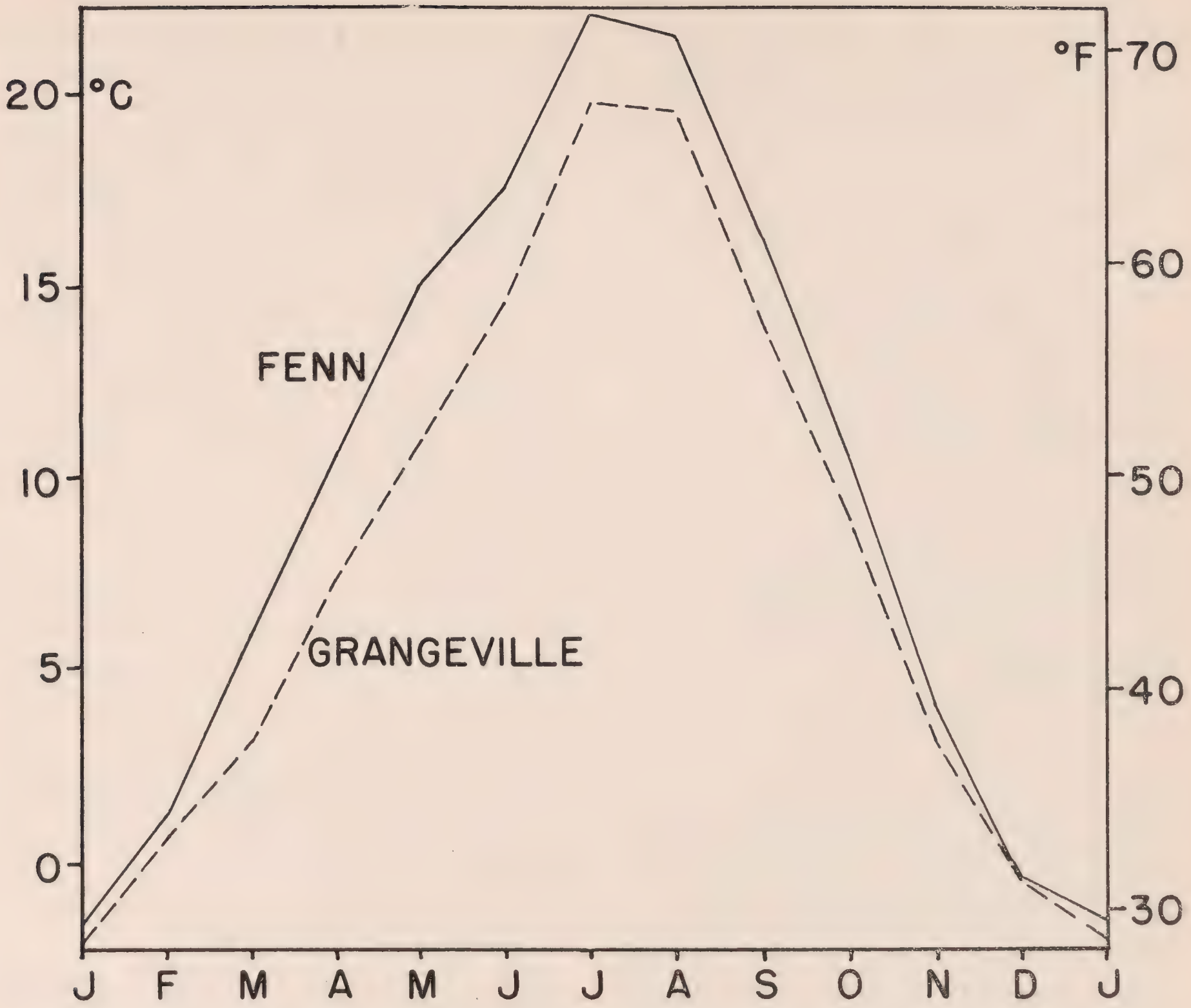

Figure 1. Annual march of monthly mean temperatures at Grangeville and at Fenn Ranger Station, Idaho.

If these four points establish the superiority of plant life as a criterion of zones, there seems to be little question that areas should be classified only on the basis of their *climax* vegetation. Climax vegetation is any type which appears capable of perpetuating itself indefinitely on a habitat, rather than one which shows evidence that it is being, or can be replaced by another type. If destroyed by fire or some other catastrophe, it eventually reappears providing the area is not subject to other disturbances before this can take place. When vegetation is not climax (which is usually the case in densely populated regions and commonly the case elsewhere) it is always progressing inexhorably in that direction. Such vegetation change usually involves a series of distinct communities that follow each other in orderly progression then culminate in the climax. Therefore if a life zone classification were based on any but climax types, the zonal status of an area could change several times during a century! Such a classification would be much like classifying caterpillars with worms, or the zoospores of algae with flagellates. This dynamic aspect of biologic populations is one of the major phenomena that have complicated the development of a sound life zone system. Most biologists who are not plant ecologists yet who have desired to use the life zone concept have looked for an easy and fool-proof method of classification that requires little background of technical knowledge, particularly an understanding of plant succession. The required basis of factual information necessary for an intelligent use of the life zone concept is not great, yet it is indispensible.

VEGETATION ZONES OF THE NORTHERN INTERMOUNTAIN REGION AND THE CRITERIA FOR THEIR RECOGNITION

TUNDRA

1. Sedge-grass zone

CONIFER FOREST

2. Spruce-fir zone
3. Arborvitae-hemlock zone
4. Douglas fir zone
5. Ponderosa pine zone
6. Juniper-pinon zone

PRAIRIE

7. Fescue-wheatgrass zone
8. Wheatgrass-bluegrass zone
9. Needlegrass-gramma grass zone

SEMIDESERT

10. Sagebrush-grass zone

Sedge-Grass Zone

The sedge-grass zone embraces all areas above the limits of forest growth. Except where cliffs and talus slopes prevent it, the sedge-grass zone is separated from the forest below by a transitional belt in which tree cover is discontinuous and the individuals dwarfed and distorted. The aspect of the vegetation above upper timberline various from a dense, meadow-like cover dominated by sedges and grasses, through open gravelly surfaces supporting only scattered plants chiefly of the cushion form, to masses of angular boulders which are practically devoid of vegetation except for lichens and a few herbs growing in the crevices.

Spruce-Fir Zone

The spruce-fir zone is always the highest of the forest zones. Where the vegetation has escaped fire and logging, the zone is indicated by the dominance of one or more of: Engelmann spruce, subalpine fir, and mountain hemlock. Where the climax forest has been destroyed, temporary forests of lodgepole pine, whitebark pine, western white pine, western larch, grand fir, or Douglas fir occupy the ground, but even in these temporary forests the species of young trees growing in the shade indicate the nature of the ultimate stand and hence the zonal status. Should all the trees be destroyed, areas covered with dense stands of one or more of the following probably belong to the spruce-fir zone: pigeon berry *(Vaccinium scoparium)*, fool's huckleberry *(Menziesia ferruginea)*, rhododendron *(Rhododendron albiflorum)*, beargrass *(Xerophyllum tenax)* and woodrush *(Luzula glabrata)*. Huckleberry *(Vaccinium membranaceum)*, which is very abundant in the forests as well as on burned areas in the spruce-fir zone, is also abundant locally in the next lower zone so that its indicator significance is not to be trusted.

Locally various types of herbaceous or shrubby vegetation may permanently occupy small areas in the spruce-fir zone where the soil is either too dry or too wet for tree growth, or where the persistence of snowdrifts late into summer prevents tree establishment. Similar areas, commonly called "parks," are found in lower zones as well.

Arborvitae-Hemlock Zone

The abundance of either western arborvitae or western hemlock, or both, are the perfect indicators of the arborvitae-hemlock zone. Herbs abundant only in this zone are: *Tiarella unifoliata*, dwarf dogwood *(Cornus canadensis)*, oak fern *(Phegopteris dryopteris)*, and certain wintergreens *(Pyrola chlorantha, P. picta,* and *P. uniflora)*. Trees found on burned or logged areas include western white pine, western larch, lodgepole pine, grand fir, Douglas fir, ponderosa pine, quaking aspen, paper birch, and black cottonwood.

Douglas Fir Zone

Areas where Douglas fir is well represented but where arborvitae, hemlock, spruce, subalpine fir, and the herbs listed in the preceding paragraph are absent, should be classified as Douglas fir zone. Ponderosa pine is the most characteristic tree to come in temporarily on burned areas, but western larch, and lodgepole pine may also play this role. *Arnica cordifolia, Arenaria macrophylla,* and *Calamagrostis rubescens* are characteristic undergrowth species.

Ponderosa Pine Zone

The ponderosa pine zone may be recognized by the presence of ponderosa pine with the complete absence of all other coniferous trees. The undergrowth varies from a mixture of prairie grasses and forbs to a continuous understory of all deciduous shrubs, among which ninebark *(Physocarpus malvaceous)* is most conspicious.

Juniper-Pinon Zone

In the central and southern Rockies there is frequently a well-marked zone, lying just below the ponderosa pine belt, which is dominated by junipers and/or the nut pines *(Pinus cembroides* and vars.). In the northern Rockies this zone is very poorly represented. Only one species of arborescent juniper extends this far north, and the nut pines stop far short of the region, although limber pine becomes their ecologic equivalent at this latitude. Fragmentary stands of juniper *(J. scopulorum)* and limber pine barely suggest a separate zone, and these lie entirely to the east of northern Idaho.

Fescue-Wheatgrass Zone

Areas where there are no coniferous trees or indications of their former presence, and where the forest-indicating shrub ninebark is absent, were originally prairie or semidesert. The fescue-wheatgrass type of prairie can be recognized by the following characteristics: Bluebunch wheatgrass *(Agropyron spicatum)* produces rhizomes but flowers sparingly; dwarf specimens of rose *(Rosa spp.)* and snowberry *(Symphoricarpos albus)* are abundant but inconspicuous except in thickets on north-facing slopes; large forbs are conspicuous in summer; Sandberg's bluegrass *(Poa secunda)*, if present, is common only on rock soil. Characteristic species among the forbs are wild geranium *(Geranium viscosissimum)*, wild sunflower *(Helianthella douglasii)*, yellow Indian paintbrush *(Castilleja lutescens)*, cinquefoil *(Potentilla gracilis)*, lupine *(Lupinus sericeus)*, etc.

The fescue-wheatgrass zone is known to occur only in a belt along the western edge of the mountains from Grangeville, Idaho, and Fossil, Oregon, northward to Spokane, Washington, and in a similar position north of the Okanogan Highlands in British Columbia. Because it includes the best farming land in the region, most of the zone is under cultivation and relic areas of near-virgin prairie needed to recognize the zone are rare except in fence corners, rural graveyards, and along railways.

Wheatgrass-Bluegrass Zone

The wheatgrass-bluegrass zone differs from the fescue-wheatgrass zone in the following features: bluebunch wheatgrass is definitely a bunchgrass and produces inflorescences in abundance; dwarf rose and snowberry are absent; grasses are far more conspicuous than forbs, even in summer; Sandberg's bluegrass is abundant everywhere, on deep as well as shallow soils.

The area covered by this prairie is considerably larger than that covered by the fescue-wheatgrass type. It extends from the vicinity of Spokane to Walla Walla, Washington, to Pendleton then Ashwood, Oregon, and then from the mouth of Lill Creek, Oregon, to the vicinity of Ft. Simcoe, Washington. Other areas occur in southern British Columbia and in the valleys west of the continental divide in Montana.

Needlegrass-Grama Grass Zone

The major area of the needlegrass-grama grass zone lies east of the continental divide and hence outside of the region under consideration, but the type is found to a limited extent west of the divide in Montana where it alternates with the wheatgrass-bluegrass type. It is recognized most easily by the presence of grama grass *(Bouteloua gracilis)* for the reason that the other principal dominant, needlegrass *(Stipa comata)*, is often lacking because of heavy grazing.

Sagebrush-Grass Zone

The presence of *Artemisia tridentata* is the only reliable indicator of the sagebrush-grass zone.

* * * *

The fact should be pointed out that absolute indicators of zones are not

abundant. No matter what the basis of a zonal classification ,the majority of species of plants and animals range into two or more zones. Yet it is possible to separate zones on the basis of *groups* of common indicator species as mentioned above, and the zones so delimited become highly distinctive through very evident differences in the *relative abundance* of species in each. Herein lies the reason why zones seem rather vague from a strictly taxonomic standpoint but emerge as real entities to trained field workers who take into account *communities* of organisms. The differences between adjacent zones are analogous with the differences between adjacent geographic subspecies, for the latter are frequently differentiated only by the relative abundance of certain genes in their populations (Dobzhansky, 1941; Huxley, 1943).

Still another important fact must be taken into consideration by all who would use the zonal concept. Zonal boundaries seldom follow contours closely. As a rule, each zone attains its lowest altitudinal limits in valleys and its highest limits on ridges, which results in considerable interfingering, although this in no way alters the zonal sequence or its importance. Because of interfingering, the zones along the sides of a narrow valley occur in exactly the reverse order of their general altitudinal relationship as indicated previously. The magnitude of this phenomenon is exemplified by the fact that the arborvitae-hemlock zone descends to 488 m along the Clearwater River in Idaho, whereas the fescue-wheatgrass prairie ascends to 1039 m on the adjacent plateau. In all such instances the vegetation zones maintain an inviolate ecologic re- tionship to each other. On account of erfingering the use of absolute ex- sions of altitude to characterize s is inaccurate unless they refer to e extremes of vertical extension, and hey become rather meaningless of the tremendous everlapping results from interfingering.

e question might be raised as to to classify small strips and islands of one vegetation type surrounded by extensive areas of another zone, as for example, the disjunct islands of ponderosa pine that occur on protected slopes of canyons in the basal plains otherwise covered with prairie. These stands are truly located in prairie *macroclimates,* but the microclimates within the stands are more similar to the microclimates of other pine stands than to the microclimate of the prairie community. Consequently the undergrowth, insects, birds, etc., are species definitely characteristic of the ponderosa pine zone, and the areas are best classified as ponderosa pine zone despite their small size and isolation. Herein lies the best argument against the use of the term "bioclimatic" zone, for climate is definitely not the sole controlling factor in the distribution of dominant plants, yet these dominants, regardless of differences in macroclimate and soil, tend to create similar microclimates. The term bioclimatic zone implies a significant degree of uniformity in climate as well as biota, but uniformity is approximately true only in regards to microclimate.

ZONAL VERSUS INTERZONAL VEGETATION

In addition to the major types of vegetation already described, numerous less extensive ones exist as islands in the matrix of zonal vegetation. They are almost always found where some extreme condition of the soil (wetness, sandiness, saltiness, etc.) prevents the development of normal zonal vegetation, and as they are seldom restricted to one zone, they may be called *interzonal.* Some examples are provided by the parks mentioned in discussing the spruce-fir zone, by greasewood scrub which occurs on wet saline soils in the sagebrush-grass, wheatgrass-bluegrass, and needlegrass-grama grass zones, and by alder *(Alnus sinuata)* thickets which occur in moist draws in the arborvitae-hemlock and spruce-fir zones.

UTILITY OF THE ZONAL SYSTEM TO FIELD BIOLOGISTS

One of the most important applications of the zonal concept is its useful-

ness to collectors and other field workers in designating locations and correlating field data. The zonal system functions well as a hatrack upon which to hang distributional facts.

A specimen or sight record of occurrence should be classified first as to the plant community in which it occurs. If this community is the characteristic climax of the zone (e.g. spruce-fir forest) no further data of sociologic nature are necessary, but if it is a temporary type (e.g. lodgepole pine forest) or an interzonal climax (e.g. wet sedge meadow), both the plant community and the zone in which it is found should be indicated for adequate classification. Thus, a mouse collection is well designated if the label reads "cheatgrass community in an abandoned field in the sagebrush-grass zone," and a mushroom collection assumes ecologic significance if accompanied by such a notation as "western white pine stand in the spruce-fir zone." It is to be noted that the designation "ponderosa pine forest" is inadequate, for it would not indicate whether the location was a habitat upon which this forest is climax, or whether it was in the distinctly cooler and moister Douglas fir zone where the pine may dominate for one generation after a fire.

The fundamental significance of the zonal concept in forestry, range management, and game management is made clear from the fact that each zone indicates different potentialities for plant production. The natural trends in plant succession as well as the possibilities for controlling vegetational change are not the same in any two zones. It is beyond the scope of this paper, however, to elaborate upon this aspect of the utility of zones.

CONCLUSIONS

Zones based on temperature are untenable, for this procedure results in lumping dissimilar vegetation together in certain regions and splitting homogeneous entities in others.

When zones are delimited from the standpoint of species distribution, they are, by the admission of both taxonomists and ecologists, poorly defined.

Life zones are most distinct, they most nearly approximate environmental equivalence (and therefore have the greatest ecologic significance and utility) when delimited on the basis of the major climax plant associations. Most plants are subordinates that depend upon the presence of the few dominant plants which control the microenvironment; thus the relative abundance of most plants undergoes a distinct change at the boundaries of zones. Likewise, animals are usually subordinates; their distribution tends to follow the zonal pattern established by vegetation, because animals depend upon the plants directly or indirectly for food and shelter. Because the range of conditions which plants demand for germination and establishment are narrower and more specific than food and shelter requirements of animals, the distribution of animals appears less strongly influenced by the zonal pattern than is the distribution of subordinate plants.

The terms "life zone," "biotic province," "biome," and "biogeographic area" have certain merit because they suggest the entire galaxy of plants and animals that vary in relative abundance from one zone to another, but the use of the term "vegetation zone" is the most precise expression because the immediate control over both animals life and soil development is the vegetation. The pattern of vegetation zones in turn is controlled by factors governed by the interplay among climate, topography, and soils.

For the reasons just given, vegetation zones are fundamental natural entities indispensible to field workers in botany, zoology, and pedology.

The term *vegetation zone* represents a concept, as does the term *subspecies*, and it is as real and as capable of precise definition as is the subspecies. To carry the analogy farther, zones no less than subspecies cannot be identified without a certain minimum of technical knowledge and experience.

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ABSTRACT OF REPORT PREPARED FOR ANNUAL MEETING OF THE NORTHWEST SCIENTIFIC ASSOCIATION, SPOKANE, WASHINGTON, DECEMBER 27, 1945

Results of Cultural Trials in the Establishment of Perrenial Forage Species on Abandoned Farmland in Southeastern Idaho

Prepared by

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Field trials conducted at Aberdeen, Idaho, since 1939 by the Soil Conservation Service, U. S. Department of Agriculture, and the Idaho Agricultural Experiment Station demonstrate that desirable perennial forage species may be established on abandoned dryland under low rainfall conditions.

The average annual rainfall from 1912 to 1945 for the area in which the trials were conducted was slightly less than 9 inches. Yearly rainfall received during the trial period, 1939 to 1945, includes the highest as well as the lowest annual precipitation on record.

At the time the trials were established the vegetative cover supported by the area was primarily annual cheatgrass (*Bromus tectorum*). Only very scattered plants of perennial forage species were present.

The trials have included different cultural methods of seedbed preparation and common as well as newly introduced or recently domesticated species and strains. Plantings have been made with types of drills commonly used in dryland areas. Seedings were established on seedbeds prepared by summerfallow, duckfooting just prior to seeding, and burning in the early summer as well as on unprepared seedbeds. Most seedings were established in the fall, but early and late spring seedings have also been made. Pure stands as well as mixtures have been used.

Summerfallow is the surest and best method of preparing abandoned land for reseeding. It reduces competition and destroys or partially eliminates undesirable species. Summerfallow also makes possible the use of a greater number of species and permits spring as well as fall seeding.

Satisfactory stands may be established on burned or duckfooted areas, but the plant development is retarded in comparison to similar stands on summerfallow. Some satisfactory stands were established on unprepared seedbeds, but the failures and spotted stands obtained indicate that this is not a reliable method for the establishment of perennial forage plants. Stand development on unprepared seedbeds was delayed from 2 to 3 years as compared with similar seedings on summerfallow land.

No significant differences have been obtained in yield from the use of different drills when seedings were made on summerfallow. The double disc drill produced the most uniform stands on duckfooted seedbeds while the deep furrow drill was superior on unprepared seedbeds.

Equal success has been obtained from fall and early spring seedings on summerfallow. Late spring seedings were successful in 2 out of 3 years.

Pure stands of crested wheat grass (*Agropyron cristatum*), bluebunch wheatgrass (*Agropyron spicatum*), and tall wheatgrass (*Agropyron elongatum*) seeded on summerfallow produce essentially the same grazing capacity per acre. The average grazing capacity of these three species was from 2 to 4 times that of the annual cheatgrass.

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The blue bunch and tall wheatgrass require at least a year longer than crested wheat for complete establishment. Fully established stands of western wheatgrass (*Agropyron smithii*) and thickspike wheatgrass (*Agropyron dasystachyum*) were equal to the bunchtype wheat grasses in grazing capacity. Alfalfa has developed satisfactory stands on summerfallow but does not produce sufficiently under the condition of these trials.

Mixtures have no advantage from the standpoint of production over pure stands. The production of bluegrasses or sod-type wheatgrasses in combination with bunch wheatgrasses is determined by the yield of the bunch wheatgrass.

Yields correlated with basal density of most species used in the trials. The average basal density of adapted perennial wheatgrasses was 2.67 per cent with an average yield of 1173 pounds of forage per acre. Cheatgrass with an average basal density of 2.64 produced 607 pounds per acre.

Complete results of this work are in manuscript form for publication as a bulletin by the University of Idaho.

CURRY COUNTY; THE GEOGRAPHY OF AN ISOLATED COAST

WILLIS B. MERRIAM[1]

INTRODUCTION

The Curry County coastal region of southwestern Oregon is one of the most isolated sections of continental United States. Its handful of pioneers have struggled for years against odds of adverse topography and soils, wet and windy climate, and isolation from major market centers. Eking out a subsistence in timber product industries, sheep, fish, marginal mining and forage agriculture, its inhabitants have traditionally resigned themselves to neglect at the hand of more populous sections of the state, and resented their lot. Sharing this feeling of neglect with Siskiyou county, California, and other isolated counties of Northwestern California and Southwestern Oregon, they went so far as to seriously purpose secession from Oregon in 1941, joining the state of California, or leaguing with other isolated counties in the formation of a separate state.

In comparison with other counties in Oregon 14 of the 36 in the state are smaller in area than Curry, yet the total county valuation, according to the Oregon Blue Book of 1942, was under $4,000,000, the lowest of any county in the state, and the total farm valuation, according to the 1940 census, was scarcely $3,000,000. But in the last few years Curry county discovered an agricultural specialization in lily bulbs that in four years stepped up the total value of agricultural products from $540,000 in 1940 to over $2,000,000 in 1945.

There is always popular appeal to the success story, whether of an individual or a region. It will be the task of this paper to analyze the coastal strip of Curry county, tell the story of its struggles against environmental odds, its recent rise to prominence, and to draw conclusions as to its future outlook.

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THE NATURAL ENVIRONMENT

Curry county is located on the extreme southwest coast of Oregon, bordering the state of California. Road map figures indicative of its isolation only tell part of the story. It is located on the picturesque but commercially none-too-practical Pacific Coast highway, over 400 miles from San Francisco to the south and 360 miles from Portland to the north, the nearest market outlets. Seventy-five miles to the east across the rugged Oregon Coast range and the Klamath plateau lies Medford, but no traffic ways as yet have conquered the rugged canyons of the lower Rogue River.

Physiographically it consists of narrow intermittent coastal plain and old beach terraces; interrupted by imposing headlands of basalt and older metamorphics, where the Oregon Coast range and the Klamath peneplane meet and merge. An interesting and significant feature of the region lies in the beach terraces, sandy, wave-cut and variously eroded steps, sometimes several hundred yards wide, representing old fossil shore lines, uplifted at elevations of 40, 100, 220, 500, 100 and 1500 feet. Most of these terraces are considered useless for agriculture; their main use being a ready-made series of level platforms along which the coast highway has been built. The hinterland is exceedingly rough and mountainous and virtually untennanted.

Climatically the region represents the wetter phase of the Temperate Marine type of climate, with cool damp winters and a short summer that may reach warm-dry conditions. Total rainfall is heavy. Port Orford averages 67", Gold

Beach 75" and Brookings 70" along the immediate coast. Langlois, on the 500 foot terrace, receives more than 99". Winter months at each of the stations receive 10 or 11 inches; summer months about half an inch in July and August. The total varies considerably, however; Port Orford has received as little as 44" and as much as 119". Highest temperatures in summer have reached 100 degrees F. at several stations. Minimum temperatures in winter have dropped as low as 19 degrees F. above zero. The growing season is long, averaging 238 days at Langlois and 286 at Port Orford. Growing season data also shows considerable variation. Brookings, for example, has had a frost-free season as short as 219 days and as long as 312; Port Orford's range is from 194 days to 365. However, the general climatic conditions all along the coast reveal heavy rainfall, mild temperatures, and virtually a subtropical-length growing season, restricted somewhat by excessive cloudiness.

Under these conditions of topography, soil, and climate the natural vegetation of Curry county, in the more exposed stretches, consists of coastal grasses, furze, wild hazel, bracken, and other brush forms. The protected back lands and better soil areas are wooded with small stands of Douglas Fir, Western Hemlock, Sitka Spruce, and the relatively rare Port Orford Cedar. Minor stands of Balsam Fir are also found. Curry County shares with Coos County, immediately to the north the possession of important stands of the rare California Laurel or Oregon Myrtle, providing a basis for a small-scale industry devoted to the manufacture of Myrtlewood novelties.

HISTORICAL GEOGRAPHY

Although the coast was described and some place names affixed by Captain George Vancouver in 1792, the first settlement at Port Orford did not take place until 1852. Throughout that year hundreds of miners bound for the Rogue River gold fields landed at Gold Beach on their way to the Josephine and Jackson county mines.

In 1855, four years before Oregon was admitted to the Union, the Oregon territorial legislature created Curry County from the southern extension of Coos county. During the succeeding years the Indians were brought under control, but with scarce gold resources many of the miners and traders left the country. Some remained, however, and took up the raising of livestock, worked in small lumber mills, or engaged in fishing around the mouth of the Rogue River at Gold Beach.

Population growth was slow. In the 1850's several hundred men and their families settled at three or four of the more favorable centers, true pioneers, subsisting mainly on the free goods of the land. By 1900 only 1,868 inhabitants were recorded in the census. By 1910 the figure was 2,044; ten years later 3,025. In 1930 3,257 were counted, and the last census in 1940 listed 4,301.

With the completion of the Coastal Highway and an influx of tourists, three main centers entertained substantial growth, Port Orford listing 755, Brookings 544, and Gold Beach 841. Until 1928, Gold Beach, the county seat, was the only county seat in the United States that was unincorporated.

PRESENT ADJUSTMENTS

Under the heading, present adjustments, will be included the normal economic activities that engaged the people of Curry county up to 1943.

The leading interest of the region centered around the raising of livestock, particularly sheep. Sheep raising is confined to hilly and logged-off land, and to the coastal moors. These animals do not require supplementary feeding in this area and go through the winter, as a rule, in excellent condition. The mild cool and damp climate produces a long staple wool, similar to that of the Penine and Cheviot hills of England and southern Scotland, with the result that Curry county wool was in especial demand for army blankets and G.I. woolens during World War II.

Open range feeding and careless tending would imply that the sheep industry of Curry county is particularly free from problems. Such an assumption is hardly the case, however. Climatic variations sometimes cause considerable loss on the range. A March 13, 1936 dispatch from Gold Beach is illustrative:

"Losses in Curry county lamp crop because of starvation and exposure may run as high as 70 per cent, R. M. Knox, county agent, said today after studying reports from ranchers. The dry autumn delayed grasses to such an extent that they were beginning to grow about the time the severe winter storms occurred and lambs which did not die from the snow were starved to death by lack of feed. Ewes did not have enough forage to produce nourishing milk, Knox said."

Every winter there is some loss of older ewes, especially among those who fail to be rounded up for shearing, and consequently become weighted down with wet fleeces during the winter rains, but this loss is more than compensated for by the low-cost care normally received.

The sheep industry of the region is limited only by range conditions, with the result that an active reseeding program has been instituted. Burned and logged-off lands, in particular, have been heavily reseeded. Local ranchers continue the pioneer practice of burning brush and bracken whenever dry seasons permit, and have developed skill in burning understory beneath forest stands without materially damaging the trees. Normal carrying capacity for the county is between 25,000 to 30,000 head, although in 1936, due to the dry fall followed by a severe winter, as indicated by the above clipping, numbers were reduced to 15,000. With nearly a million acres suitable only for grazing, and with the county taking back annually many tax delinquent acres, additional plots of actual or potential range land available at values as low as 50c to $1.00 an acre provide an opportunity for expansion of the sheep industry. The goal is 60,000 to 80,000 head of sheep, according to R. M. Knox, county agent. Improved pastures are his hope, and he cites, with climatic and topographic similarity, New Zealand, where in recent years the sheep range carrying capacity has risen from one ewe per acre to five per acre through range improvement.

Normal wool yields run 178,000 pounds, according to the 1940 census.

The lumber industry is minor in the county, and is centered mainly at Port Orford. Much of the county is in National Forest, and as such is subject to Federal cutting and fire-control measures. At present 165,406 acres of timber over 20 inches in diameter are classed as forest lands and should remain in permanent forest. Much of this forest is merchantable either as pulpwood or lumber and should be regulated on a sustained-yield basis. Myrtle Groves, especially, should be utilized carefully, as this tree grows only here and in Coos county. (The only other known stands of this wood are in Palestine.) Port Orford cedar is a rapidly diminishing resource that likewise should be restocked and cut on a sustained yield basis.

Commercial salmon fishing is centered around Gold Beach at the mouth of the Rogue River, although sport fishing interests have been instrumental in restricting the commercial catch in recent years. A few miles south of Gold Beach crabs, clams and rock oysters are procured. Frequently a pattern of part-time fishing and part-time farming supplements both activities.

Tourism is a recent and promising activity. Highway improvement has encouraged many tourists to stop at Port Orford, Gold Beach, and Brookings, for sport fishing, hunting, and summer camping.

Mining has had a long and varied history in the region. Both placer and quartz gold mining have been significant since the first years of settlement in southwestern Oregon. Place names, such as Gold Basin Butte and Mineral Hill in the mountainous hinterland and Gold Beach on the coast, are indicative of this activity. Beach mining has been an industry of minor importance for many years, and in time may increase in significance. Gold, platinum, and chrome have been taken from the

"black sands" of the coastal beaches and the terraced slopes. Values assay high, but the problem of profitable separation remains. The technology of commercially handling black sands is at present being investigated by a number of interested geologists and mining engineers from the region. A rather unusual occurrence of graphite occurs in one long dyke near Brookings. Concentrations of pure amygdaloidal graphite are abundantly scattered along the dyke and await a technological development for profitable extraction.

Agriculture has normally been of minor importance. Three hundred and seventy-five farms were reported in 1940, with a total produce valuation of $540,000. Only 104,332 acres were reported in farms that year, comprising 10.1 per cent of the total land area of the county. Corn, potatoes, and hay were the leading crops raised.

THE RENAISSANCE OF BULBS

The new development that has revolutionized the agricultural industry of Curry county dates back to 1939, although tangible results were not forthcoming until 1943. Prior to the outbreak of World War II over 25,000,000 lily bulbs were imported from Japan, with Holland and Bermuda also contributing. At that time American production was less than 1,500,000. With the coming of hostilities both Japanese and Holland sources were completely cut off, and Bermuda's supplies were sharply reduced, providing a high priced market for domestic Easter lily bulbs.

Curry county, with sandy loam soils and a unique combination of climatic factors on the old beach terraces between the 100 foot and 500 foot levels was found to be ideal for the production of bulbs.

The story starts with Sydney Croft, a migrant farmer from Michigan, who through failing health and fortunes left Michigan and came to Oregon in 1939. Familiar with bulb culture in Michigan he put in an experimental acreage near the community of Brookings. Croft succeeded in producing good bulbs within two or three years, but without an established market name he was forced to sell bulbs for 5c that three years later were to bring a dollar. However, even in those days he encouraged several of his neighbors to grow bulbs in the hopes of establishing a reputation for the Oregon bulbs. Croft died shortly after pioneering the industry, and today in his memory, the leading bulb from Oregon is known as the Croft, although a modification, the Kenyon-Davis, is becoming equally well known on the market.

As a result of these early efforts to produce a high quality bulb, plus the sudden demand as a result of the war, the renaissance of Curry county came about. In 1944 stories that rivalled the tales of Paul Bunyan were being told in the streets of Brookings. One grower reported the sale of $6,000 dollars worth of Croft bulbs from a crop produced on a corner lot. Land values catapulted. One newcomer bought a single acre in 1942 for $1,000. In 1944 he was offered $10,000 and refused. In 1944 over 50,000 bulblets and 5,000 commercials were sold from another small acreage, valued at $9,000. In 1945 actual transactions involving sales of small acreages of lily land at $2,000 per acre were recorded.

The upshot of the bulb development up to the end of 1945, with information supplied by personal correspondence with C. H. Young, cashier of the Curry County Bank of Gold Beach, R. M. Knox, Curry County Agent, and Dr. Frank P. McWhorter, Plant Pathologist, Oregon Experiment Station, Corvallis, presents the following statistical picture. There are now nearly 1,000 lily growers in Curry county, the number of farms in the county has doubled since the 1940 census. Bank deposits have increased more than 300 per cent, and profits from an acre of ground range from $10,000 to unverified yields as high as $20,000. Curry county is suddenly proud to be a political constituent of the State of Oregon and Oregon is equally proud to claim Curry county. Total bulb sales during the fall of 1945 approximated one and one-half million dollars.

But what of the future? Is this industry merely a Cinderella dream that will

vanish with a return of Japanese competition? Opinions differ. The end of the war will undoubtedly have a profound effect on the further development of the industry. The exceedingly high prices have come mainly from the sale of seed stock. It is fully expected that prices will decline with increased supplies. With a return of Japanese stock eastern forcers and florists will undoubtedly seek large numbers of the cheaper bulbs. However, the Curry county coastal terraces are particularly suited to the growing of a commercial Easter lily stock, and the superior quality of the bulbs developed here makes them worth three times the value of imported Japanese stock under normal conditions. Hence it is fully expected that the future of the industry will remain promising.

It should be pointed out, however, that the big boom is over. Land is now high priced, competition from imported bulbs will be felt within a year. Two years of meticulous care are required in their production, hence it is expected that few new growers will enter the field after this year. A new agricultural specialization, however, has been achieved in Curry county, and one that promises to remain of importance to the region.

CONCLUSIONS

Several conclusions may be drawn from this analysis of recent developments in Curry county. (1) The lily industry, although reaching its greatest boom in 1945, can be expected to remain the single largest agricultural specialization of the region. (2) The outlook for expansion of the sheep industry is encouraging through range improvement. (3) Timber activities, based on sustained-yield management in Douglas Fir, pulp species, Port Orford Cedar, and Myrtle wood, should continue and should become a permanent source of wealth to the region. (4) Commercial fishing will remain a strong part-time activity, and sport fishing will increase in importance, as the region becomes better known. (5) Gold mining will continue in minor importance, but new minerals, based on improved technology in handling the black sands, and possibly the commercial development of methods of extraction of the graphite ores, should open new opportunities for wealth in the region. (6) Tourism, based on sport fishing and hunting opportunities, as well as the isolated wilderness of coast, river country, and mountain highlands, increasingly available through highway development, offers increased promise.

ROOT PRODUCTION OF GRASSES AND SWEETCLOVER IN CONSERVATION MIXTURES

Abstract of talk given at the annual meeting of the Northwest Scientific Association —Soil Conservation Section—Spokane, Washington—December 27, 1945

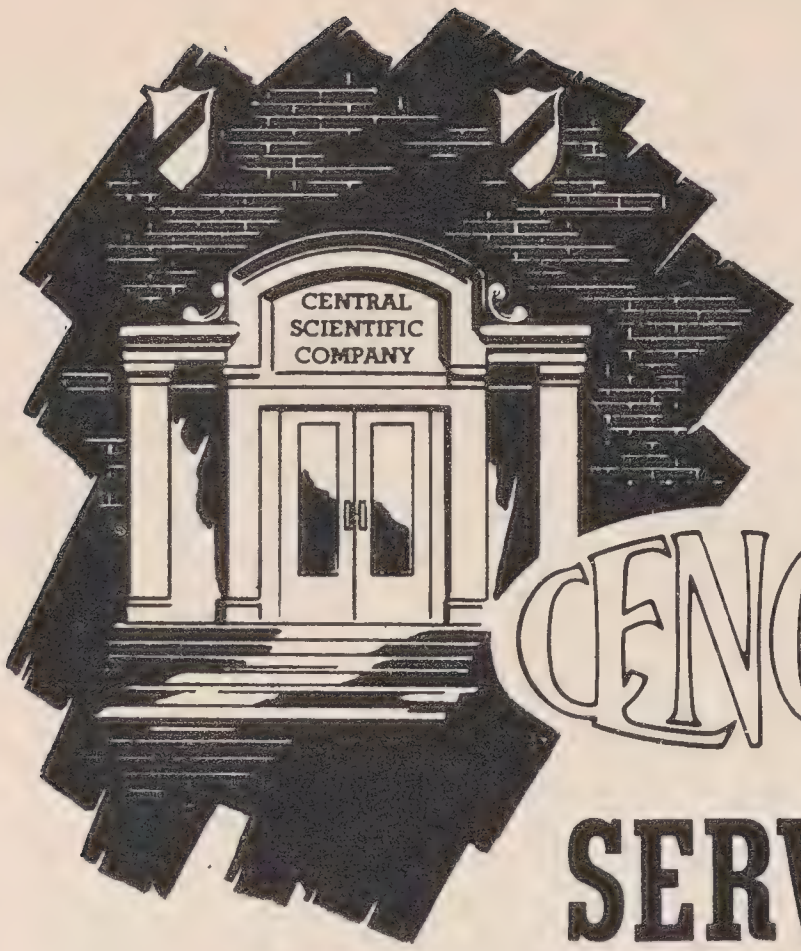
JOHN L. SCHWENDIMAN[1]

The most fertile agricultural soils of the world including Palouse silt loam were formed under a grassland cover. After 50 years of cropping to a wheat-summerfallow and wheat-pea system approximately one-third of the original organic matter and one-fourth of the available nitrogen have been depleted by cropping or by erosion. Marked erosion began when about one-fourth of the original organic matter was destroyed. Fibrous root material is practically non-existent in grassland soil after 50 years of cash cropping. Conservation nursery and agricultural experiment station studies have shown that it is possible to rebuild fibrous root material and associated erosion resisting qualities by use of grasses and grass-legume mixtures in the rotation. Since 1942 information on root production of grasses alone and in mixtures with sweetclover has been obtained as part of a sweetclover-green manure study.

Sweetclover-grass mixtures have proven superior to seedings of sweetclover alone. In the Palouse area Spanish sweetclover is recommended at 5 pounds per acre with any one of the following grasses and rates: Mountain bromegrass (deawned), 10 pounds per acre; slender wheatgrass, 8 pounds per acre; tall oatgrass (deawned), 6 pounds per acre; or orchardgrass, 5 pounds per acre. Root samples were taken to a depth of 8 inches each year just before plowing the mixtures under for green manure. Sweetclover alone had 26 percent of its total growth, as roots in the surface 8 inches. Orchardgrass which usually has a root-top ratio of 6 to 1 was the heaviest root producing grass studied. Orchardgrass in mixtures with sweetclover produced 3700 pounds of oven dry root material per acre. This was approximately twice as much as sweetclover grown alone and three times the root material of sweetclover grown in mixtures. A four year average of all mixtures studied shows that the use of grass with sweetclover adds approximately one thousand pounds of root material per acre to that obtained when sweetclover is grown alone. In mixtures 23 percent of the top production and 62 percent of the root production was found to be grass when the recommended seeding rates were used. Plowing under sweetclover to provide nitrogen and grass to provide fibrous root material and erosion resisting qualities appears to be a practical method of maintaining fertility and retarding erosion.

Apparently grass is one of the few crops that can be utilized agriculturally and still have a beneficial effect on the soil. The effect of grass roots in the soil is to increase the organic matter, increase the nitrogen, increase the calcium, increase the moisture carrying capacity and improve the physical and chemical characteristics of the soil. Grass roots decompose less readily than leguminous roots; therefore, have a longer lasting beneficial effect on soil characteristics important in soil conservation. By the addition of grass to leguminous mixtures, it is possible to increase the organic matter in the soil more rapidly than by using legumes seeded alone. Grass roots build soil.

[1] Nursery Manager U.S.D.A., Soil Conservation Service, Nursery Division, Pullman, Washington.



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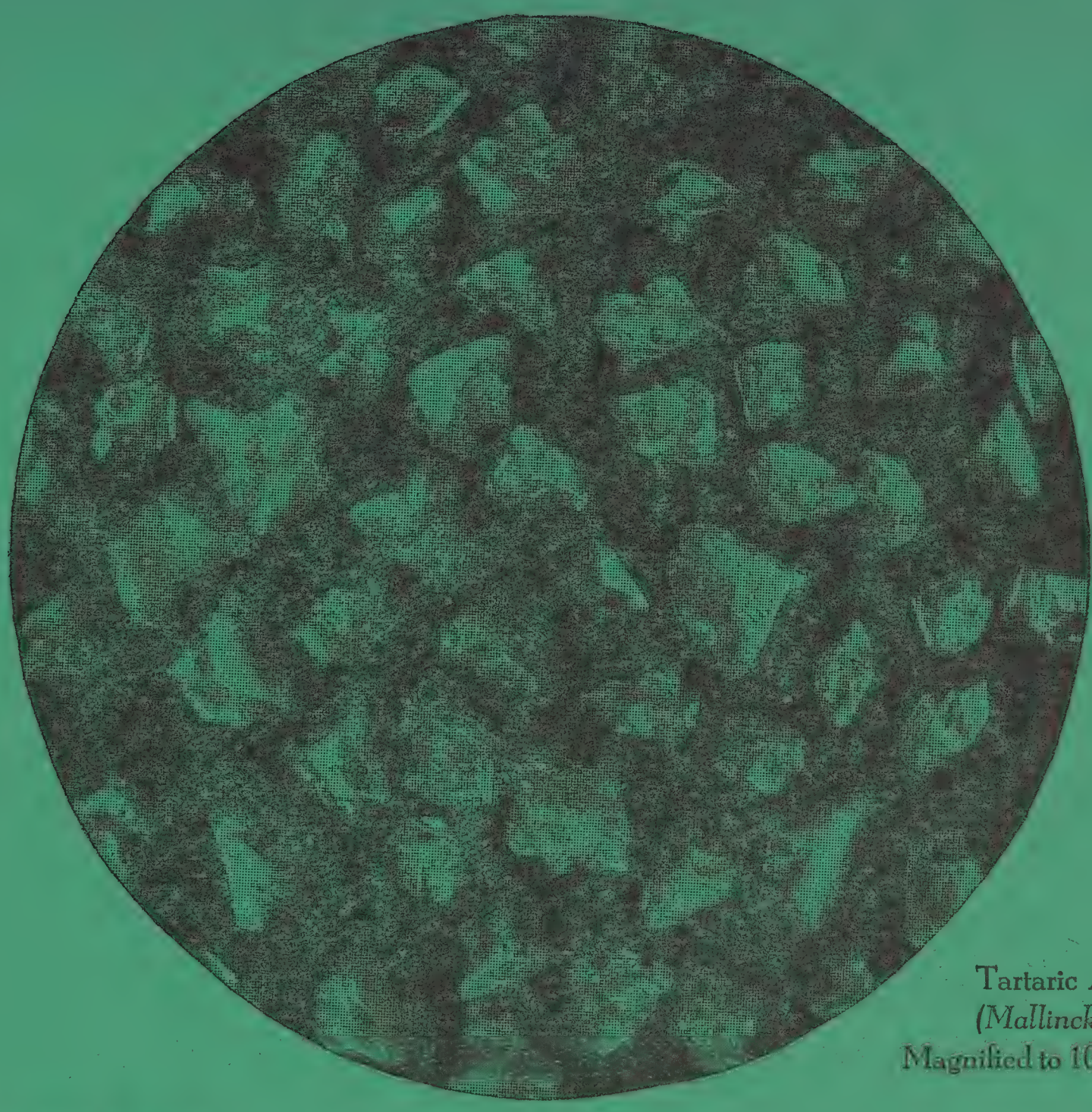

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COMMERCIAL PRINTING DEPARTMENT

NORTHWEST SCIENCE

August, 1946

Vol. XX, No. 3

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Volume XX, Number 3

1946

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, two dollars per year; to non-members, two dollars. Single copies sixty cents each. Volumes I to XX, 1927 to 1946, each $1.25. All nineteen volumes, $20.00.

Illustrations and tabular matter together should be limited to approximately twenty per cent of the total number of pages. Authors will be charged at cost rates for illustrations and tabular matter in excess of that amount (approximately $4.70 per page for tabular matter, and approximately $8.10 per page for cuts.)

NORTHWEST SCIENCE

VOL. XX, NO. 3 AUGUST, 1946

Published October 12, 1946

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Editor's Note:

Last spring the editor completed the summary of the study made by *Northwest Science* of the College Military Training Programs in the Pacific Northwest, and sent a copy to the American Council on Education. The American Council on Education, through the Director of its Commission, Implications of Armed Services Educational Programs, wired that it wanted to use the summary, in part, as a chapter in *The War and Higher Education,* a national appraisal of the college military training programs, and to publish it in its entirety as a separate monograph or bulletin.

To give the American Council on Education time to edit and publish the summary, the printing of the August issue of *Northwest Science* was postponed until this later date. Even now, we cannot give the reference to the monograph because it has yet to be published and we can only indicate that the manuscript of *The War and Higher Education* (in which the summary appears as Chapter VI, Part III) has now been submitted to Dr. Alonzo G. Grace, Director of the Commission, for eventual publication. Since the summary was edited and condensed somewhat for inclusion as a chapter in *The War and Higher Education,* and since, in this editor's opinion, the complete summary is more objective, we are reprinting the summary in its entirety, in the form it will presumably take in the monograph.

Your editor has recently received the complete manuscript of *The War and Higher Education.* Part III of the manuscript consists of contributions from "authorities" invited to participate in the evaluation by the Commission. The "authorities" and their contributions are:

Gordon K. Chalmers, President, Kenyon College. Contribution: "Collaborations in the Army Air Forces' Pre-Meteorology 'C' Colleges."

Major R. J. Connolly, formerly Chief, Training Contracts Unit, Procurement Group, Army Service Forces. Contribution: "Financial Aspects of the College Training Programs."

Edward C. Elliott, President Emeritus, Purdue University. Contribution: "The Effects of Wartime Research upon Institutions of Higher Learning."

William N. Fenton, Research Associate, Ethnogeographic Board, Smithsonian Institute. Contribution: "Integration of Geography and Anthropology in the Area Study Program of the ASTP."

W. R. Hatch, Head, Department of Botany, Washington State College and editor of *Northwest Science*. Contribution: "An Experiment in Education: The College Military Training Programs."

Sidney L. Pressey, Professor, College of Education, The Ohio State University. Contribution: "More Learning in Less Time."

Harold Sprout, Professor, Department of Politics, Princeton University. Contribution: "Implications of the Naval ROTC Course on Foundations of National Power for Civilian Education."

Chapter VI, the chapter prepared by *Northwest Science,* is introduced in these words:

> "While the war was in progress, most civilian faculties engaged in the armed services' college training programs, were keenly desirous of making objective appraisals of the military programs . . . While several educators individually authored articles pointing out the educational implications of the Army and Navy programs, in only a few instances[1] did faculties or a group of participating colleges accept the challenge.
>
> "One of the most noteworthy evaluations, and certainly one which is deserving of recognition, is the symposium sponsored by *Northwest Science*. During the last six months of 1944 and through 1945, eight collegiate institutions in the Pacific Northwest, sensing that an experiment in education was taking place, found the time to analyze their experiences. While it was true that *Northwest Science,* the journal of the Northwest Scientific Association, was the motivating factor behind the endeavor and served as the medium for reporting the series, the civilian faculty members who contributed to the series were in every instance those who had been engaged to instruct the Army and Navy trainees in the various programs at the eight campuses and these placed themselves on record before time could dull their memories or warp their opinions."[2]

W. R. HATCH,
Editor.

[1] "In addition to this symposium, which appeared between August 1944 and November 1945, in successive issues of Northwest Science, a similar series appeared in 1944, featuring certain phases of the ASTP and STAR Units at institutions in the Ninth Service Command and indicating implications for civilian education. See California Society of Secondary Education. 'The Army Specialized Training Program in the West,' a symposium, *California Journal of Secondary Education,* XIX (March 1944), pp. 76-137."

[2] *The War and Higher Education,* Part III, Chapter VI, pp. 1-2

AN EXPERIMENT IN EDUCATION: THE COLLEGE MILITARY TRAINING PROGRAMS

W. R. HATCH

State College of Washington[1]

(Reprinted in full from the monograph being printed by the Commission on Implications of Armed Services Educational Programs for the American Council on Education.

Reprinted in its more complete form from The War and Higher Education, Part III, Chapter VI, as submitted to Dr. Alonzo G. Grace, Director, Commission on Implications of Armed Services Educational Programs, American Council on Education, for eventual publication by the Commission. The compilation was prepared for the Commission by Henry Curtis Herge and his staff.)

I

THE MILITARY TRAINING PROGRAMS IN THE COLLEGES AND UNIVERSITIES OF THE PACIFIC NORTHWEST

During the last six months of 1944 and through 1945, *Northwest Science,* Journal of the Northwest Scientific Association, published a series of articles on the military training programs in which the colleges and universities of the Pacific Northwest had been engaged during the war years, 1942-1944. These programs were terminated in April and June, 1944, after having been in operation from two years to nine months, depending upon the program. *Northwest Science* began its study in July, 1944, before the faculties assembled to instruct in these programs had been dispersed and before time could dull the memories of those who had participated. The purpose of the study was to discover what lessons there might have been in these programs for civilian education. Such an experiment—one in which enough money is provided and many schools and a great many students are involved—is not often made, and it rather seemed that we could hardly afford to overlook any lessons that might have been learned in this experiment.

Eight schools cooperated in this study: Central Washington College of Education, Eastern Oregon College of Education, Montana State University, Washington State College, Oregon State College, University of Idaho, University of Washington, and Whitman College. The programs in force at these schools and reported upon in the different articles in *Northwest Science* were as follows:

1. Central Washington College of Education:
   Army Air Forces College Training Program.

2. Eastern Oregon College of Education:
   Army Air Forces College Training Program.

3. Montana State University:
   Army Air Forces College Training Program.

4. Washington State College:
   Army Air Forces College Training Program.

[1] Head, Department of Botany.

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5. Oregon State College:
   Army Specialized Training Program.

6. University of Idaho:
   Foreign Area and Language Program.
   A. S. T. Engineering and Pre-Professional Programs.
   Army Specialized Training Reserve Program.
   Naval Radio Training School.

7. University of Washington:
   Army Specialized Training Programs, Far Eastern Program.
   Army Air Forces Technical Training Program, Pre-Meteorology "B" Program.

8. Whitman College:
   Navy V-5.
   Navy V-12.

A. METHODS USED IN THE PREPARATION OF THE ARTICLES IN *NORTHWEST SCIENCE*

In the preparation of the articles appearing in *Northwest Science* from August, 1944, to November, 1945, every effort was made to be as critical and as objective as possible, for it was recognized that it was quite as important to discover what objectives and procedures could not be adapted to civilian education as it was to learn of those that might have application. The method used in the preparation of the Washington State College article and the method adopted by Montana State University and Central Washington College of Education was as follows:

1. A representative number of pre-eminently qualified persons were selected by the administrator of the program, in consultation with his staff.

2. These persons were asked to prepare papers of 500-700 words on the subject "What Were the Lessons in the Army Air Forces College Training Program for Civilian Education?"

3. The papers, all written independently, were then read by an editorial board which broke them up and built them into a single article, or symposium, by organizing the comments of the several authors under topics. The editorial board did not select the topics; they simply organized the material under topical headings, the selection being made by the authors themselves in their choice of subjects. Furthermore, all the opinions expressed on any topic were included under that topic, even though it resulted in duplication in some instances. This was done because it seemed desirable to assemble all the data and not exclude any on subjective grounds. In the integration of the several papers into a single article or symposium, material was necessarily removed from its context and topical headings were set up upon which there was, in some instances, relatively little discussion. To make certain that each writer had not been misrepresented by the removal of his remarks from their original context, and to make certain that each author had an opportunity to express himself on all topics upon which he felt qualified to write, the completed article or symposium was sent to the several contributors for their review.

Other schools used somewhat different methods. Whitman College and the University of Idaho selected panels "broadly representative of the faculuty" which met to discuss methods of presentation. The original papers, however, were written independently by the different members of the panel or panels.

Oregon State College and Eastern Oregon College of Education had, some months before, assigned five topics to certain carefully chosen persons. Their articles were prepared from these responses.

At the University of Idaho the choice of topics was influenced somewhat because their panels were given a list of the topics developed in the Washington State College article. They were, however, told to "supplement or curtail" this list as they wished.

At the other schools, the choice of topics was not influenced in any way. At Oregon State College and Eastern Oregon College of Education, as we have noted, the authors had been given certain topics to write upon for an earlier evaluation, but as far as our study was concerned, they were quite undirected in their choice of topics.

B. METHODS USED IN THE PREPARATION OF THIS ARTICLE

In the preparation of the data which follows, the articles in *Northwest Science* were re-read to make certain the choice of topics had been well made. Some new topics were, in consequence, set up — in some instances replacing old ones. "Individualized Education," "Faculty," and "Objectives" are new as are many of the sub-headings: e.g., "liberal education," "specific objectives," "student participation," etc. Since no author could possibly have been attracted or directed to these topics by any previous mention of them, this helped preserve the objectivity of the analysis.

Finally, it should be observed that the choice of topics in this paper, this final synthesis, and the selection and classification of comments under the topics were made by Mrs. Lucille O. Gustafson, secretary. Mrs. Gustafson's help was sought in the interest of objectivity, it being felt that her handling of the data would perhaps be more mechanical than mine and would be uninfluenced by any predelections of mine.

The topical headings referred to above are of the different lessons seen in the military training programs by the different contributors. The number of comments upon any topic is indicated in the brackets after each topic. The topics are taken up in the order of the frequency of comment upon them.

Every comment, i.e., every lesson mentioned in any of the articles has been recorded under some topic and these comments have been grouped, the common denominator of the groupings being indicated by sub-headings. The comments have been made as direct quotations in the interest of objectivity, if not of brevity. While the comments have been quoted directly, they have been cut to the bone to save space and reader-time.

Finally, all comments were checked against the original articles to make certain that all had been picked up and that all had been correctly quoted.

C. DATA ASSEMBLED IN THIS ARTICLE

INTEGRATION

(46)

General (9)

" . . . there is a real need and demand for an integrated education . . . a thing which we have . . . lacked . . . since the elective and vocational approaches came in with their consequent disintegration."

"A factor that aided us was the breaking down of divisions between departments . . . "

"Departmental lines [were] forgotten . . . greater cooperation between different divisions . . . resulted."

" . . . integration of materials and methods was noteworthy."

"The program was very well integrated both as to course content and sequence of courses."

" . . . efforts to correlate the work of . . . different courses and departments was very effective and worthwhile . . . to accomplish an optimum amount of correlation, instructors need to become familiar with the content of . . . the courses the students are taking."

" . . . an understanding . . . of the work of the several departments would make for more effective work."

"Unquestionably . . . instruct[ion was] improved . . . by cooperating where close cooperation was required."

"A fine spirit of cooperation pervaded the teaching force, practically daily opportunity for comparing notes being available."

Examples of (9)

" . . . greater effectiveness could be achieved by more inter-departmental planning . . . geography, mathematics and physics departments, for example, found it most easy to plan . . . "

" . . . introduced a practical form of cooperation between departments . . . staff [included] the Far Eastern department in cooperation with the geography, political science . . . anthropology department[s] and the College of Economics and Business."

"The program consisted of a language and geographical, historical and sociological characteristics of a section of a country where that language prevails . . . It [is] generally conceded that . . . [this method] is an an effective means of instruction."

" . . .teachers of languages and related social studies worked together to produce . . . coordinated programs . . . Unified programs cutting across traditional departmental lines are not only desirable but . . . attainable."

" . . . mathematics, physics and vectorial mechanics were coordinated [so[they mutually supported each other . . . topics in one course supplied subject matter for other courses . . . reports on . . . physics laboratory experiments were used . . . in oral and written communication. Such coordination is possible and . . . was found to be desirable.

"Subject matter provided by other courses was used exclusively in writing and speaking exercises . . . "

"English theme assignments . . . on . . . materials from history and geography helped students to assimilate these materials . . . This practice should be valuable . . . "

"Integration of [a] second type was more a planning of details. If, for example, the mathematics descriptive of falling bodies were taught in mathematics and also in physics, could not the same symbols be used . . . in both courses? Could not the same symbols

be used in . . . all . . . formulas studied both in mathematics and physics? . . . the desirability of uniformity was recognized and achieved to some extent."

" . . . a distinct advantage [when] chemistry and physics were taken concurrently . . . "

By democratic administrative practice (13)

" . . . frankness and democracy will summarize the administrative philosophy . . . Much of the success of our program must be attributed to its flexibility."

"Frequent conferences between coordinator and staff members were held. Problems were worked out cooperatively by staff members and coordinator . . . the outstanding feature of the program was [this] spirit of cooperation . . . between the members of the instructional staff and between the staff and the administration. [This] gave flexibility and coordination to the entire program."

". . . fortunate that a program was not adopted without administrative provisions whereby it could metamorphose and grow . . . The same should be true of any progressive educational program."

" . . . a genuine willingness . . . to make desirable changes in . . . courses as a result of interdepartmental planning [was shown by instructors]."

" . . . democratic procedure promoted the best efforts of each of the staff members."

"The ideas developed [in departmental faculty meetings] were carried on to the regular meetings between the supervisors and coordinators, where they were passed on from one department to another and general policies adopted. No one on the program had the feeling that he was being dictated to by adminisrators, but felt that he had had a part in planning the work. . . ."

"Each department was organized under a supervisor . . . supervisors formed a[n] . . . academic 'cabinet' which met with the coordinator. . . . No question of any importance was acted on by the coordinator without first hearing it thoroughly discussed by the supervisors. In this way . . . understanding developed among the supervisors on the various problems and policies of the departments. This procedure did not stop at a level of the supervisors, but was extended to the instructors who were also given an opportunity to discover how their work fitted into the program as a whole."

" . . . cooperation of . . . coordinator with . . . department heads and teaching staff was excellent . . . contributed substantially to the success of the program."

"The coordinator maintained . . . close relations with the supervisors . . . and with many of the individual instructors. Army directives were accordingly discussed . . . before they were put into effect."

"Frequent sessions of this group [department heads] were held in the coordinators' office. Cooperation . . . was commendable."

"No better illustration could be found as to how confidence in the fairness of a superior created confidence in and regard for administrative authority."

"The training was carried on under an administrative policy that evoked from members of the teaching staff a willing and cooperative effort."

"The success of the program was largely due to the administration of the work, the excellent cooperation between departments and the high correlation of work given in the departments."

By frequent faculty meetings (9)

" . . . a most important factor in . . . the success of the school [were] weekly faculty meetings in which . . . each course was . . . thoroughly discussed and evaluated."

"Regular meetings were held for the entire faculty . . . each department [taking] an entire meeting to [describe] the work of that department."

' . . . weekly [faculty] meetings . . . were a most important factor contributing to the success of the school."

"In addition to frequent faculty meetings to discuss pertinent problems relative to the objectives and functions of the program, weekly departmental meetings were held to discuss specific problems in each field . . . helped each instructor analyze his function . . . and to focus the attention of all the instructors upon the essential objectives of each department."

" . . . all departments held frequent faculty meetings."

" . . . departmental staff meetings were held often . . . found to be very inspiring."

" . . . general orientation meetings were held . . . heads of departments and instructors . . . concerned [were] invited. Such meetings were of value and were supplemented by further discussion in the faculty meetings. . . . "

" . . . required frequent conferences and a mutual understanding of objectives and procedures. . . . "

"Among the language teachers . . . general meetings were held to review aims and techniques. . . . "

By Closer Supervision (6)

"Classroom visitation by supervisors . . . helped . . . improve the quality of the teaching."

"Visitation was carried on more for the purpose of improving organization and standardizing course content than for criticism of teaching."

" . . . more supervision tactfully handled should prove valuable in civilian circles."

"In the matter of academic supervision, civilian education might profit from our experiences."

" . . . within . . . groups teaching the individual languages, coordination was achieved by daily contact with the senior instructor . . . [by] visits of the senior instructor to the laboratory classes."

" . . . head of the department should take his place among [staff] members . . . thus be able to . . . supervise the work of his own department, and correlate it with that of the other departments."

STUDENT MOTIVATION

(38)

General (4)

"We must give priority . . . to the motivation of the students."

"Grade requirements served merely as artificial motivating devices . . . a more positive kind of motivation should be striven for . . .

" . . . no long-term motivation, whether it be political, ethical, or religious. Coupled with this I found a cynicism with regard to man, individually and collectively."

" . . . the general success of the V-12 trainees offers one more piece of evidence of the utter falsity of the general . . . student attitude 'I can't do math and physics'."

Wartime incentives (10)

"The students were highly motivated by the incentives of promotion and advancement."

" . . . prospect of advancement in rank. . . . "

" . . . hope of advancement in rank . . . "

"Advancement in rating and consequent increase in pay. . . . "

" . . . incentive . . . military value in the way of Army advancement."

" . . . hoped to become officers . . . "

" . . . a commission, a raise in pay and considerable social prestige."

" . . . 'playing for keeps' . . . "

" . . . the fact that [the student] will receive flight training . . . if [he] can carry a prescribed academic load . . . is a very powerful motivating factor."

" . . . motivation . . . from a genuine patriotic impulse rather than from the selfish motive of obtaining a technical education at government expense . . . evident since many . . . men were being trained in subjects outside their previous experience or personal ambition."

Relevance (9)

" . . . mature students will require more direct motivation than credits and grades. If the course is related to the student's goals, he will work at it."

" . . . high degree of motivation . . . high especially when the aviation students believed that the subject matter of a course had a definite bearing on their immediate objectives. . . . "

" . . . greatest hope lies in engaging students in educational pursuits . . . that will help them attain a desired and foreseeable end, culturally or vocationally. . . . the fact must be faced that the society in which young people are growing up must be so organized . . . [their] goals will be available. Such a society would . . . be the greatest possible motivation for young people to desire an education."

" . . . we shall get better response from civilian students [if] we relate the study of mathematics to life problems. . . . "

" . . . when the historical material helped to cast light on a specific problem of the present, either national or international they showed a very definite interest."

"[Students] were interested in . . . the immediate background of the war and the war itself; . . . they participated with interest in discussions of current events . . . the material on the development of America's democratic institu-

tions and traditions . . . won from a majority an apathetic response."

"What more mature students want is an objective presentation of . . . ideas which have been tried throughout man's history, and an application of them to the contemporary scene."

"The law of falling bodies did not [arouse] interest . . . until it was applied to a falling bomb. The study of laws for the combination of forces was . . . dull . . . in the abstract, but was regarded quite differently when expressed in terms of the forces acting on a plane. In mathematics, likewise, when problems had direct application and recognized relevance to flying the students at once became more interested."

"The laboratory period was also used for problem work. Each experiment was accompanied by problems of direct application. . . . "

Participation (6)

"The organization of the laboratory . . . encourage[d] objective thinking. The realization that [his] own mind was capable of . . . . startling accomplishments in objective thinking was the greatest motivating force that the student experienced."

"Too often pupils 'prove' theorems in a formal way without knowing what the real substance of the theorem is; and far oftener they miss the element of direct insight that was easily brought out and used effectively in our work with the aviation cadets."

"In physics and in medical aid manipulative skills were . . . of greater interest than discussion alone."

"[The] contributions [of] individuals with special vocational experience gave solidity to the discussions."

" . . . . evidence of constructive group work often led to desired positions of leadership and frequent special privileges. This factor seemed to be of a positive nature and should certainly be . . . consider[ed] in any well-planned educational program."

"Extensive streamlining destroys the opportunity . . . to encourage individual initiative."

Audio-visual aids (5)

"The use of audio-visual training aids . . . increased student interest in subject matter and produced more work in less time."

" . . . possibilities of using visual aids on a much larger scale to present materials essentially factual to larger groups."

"Extensive and effective use of visual aids . . . "

" . . . greater use of audio and visual aids . . . "

"As supplementary teaching material gramophone records were used . . . not only made by the teachers but also by the students themselves . . . "

Competition (4)

"Element of competition . . . was a stimulus that helped keep individuals up to their best efforts."

" . . . competition . . . I know of no better way to stimulate both teacher and student."

" . . . competition . . . "

" . . . frequent testing of students tends to increase both their interest and their efforts."

INDIVIDUALIZED EDUCATION

(33)

General (16)

"The students were . . . trained in small groups . . . "

" . . . the number of instructors and size of sections employed by the Army do not fit into the civilian pattern except in rare cases."

"The fullest provision was made in planning and instruction for individual differences."

" . . . much closer relationship between teacher and student—a greater interest in the individual student."

" . . . given more individual instruction than ever before . . . the study habits of . . . individual[s] [were] more closely scrutinized . . . as a result, failures in . . . courses have been fewer . . . It is hoped that this increased efficiency in teaching will carry over to the postwar period."

" . . . to give individual attention where needed was paramount to success in laboratory work."

"The traditional laboratory procedure in the first year physics . . . needs complete recasting. Where large groups of students are handled in the laboratory, nearly always the procedure degenerates to a cut-and-dried repetition of standard experiments . . . all too often with with no idea of what he has done or why he has done it . . . departments should provide facilities . . . for good students to experiment on their own initiative."

" . . . reaffirmed the . . . theory that education succeeds best when the total or whole individual is exposed to the process. While higher education in the past has all too often rendered only lip service to "wholism' the recent results of the service programs may serve to stimulate interest in the whole individual."

"For effective teaching . . . the importance of understanding the individual's interests and problems was essentially the same in these programs as in civilian instruction . . . There seemed to be . . . confidence and understanding between . . . trainees and . . . instructors . . . "

"[We should] know more of the background and interests of our students."

" . . . necessary that techniques be developed in the classroom for . . . overcoming individual learning difficulties."

"The program demonstrated . . . the importance of keeping the instructional program on the maturation level of the students' purposes and needs."

"[The] faculty knew the men as individuals through class contacts and frequent conferences."

" . . . important to devote class time to helping individual students. . . . Almost every student has difficulties . . . unique to himself. . . . Individual conference provides [a] way of spotting these difficulties and helping students overcome them."

" . . . obvious values of conferences and individual aid . . . which become complicated with larger groups of students. . . . "

"The V-12 program . . . added impetus to the development of . . . student counseling and guidance . . . and . . . demonstrated the importance of such a program. . . . "

Sectioning (14)

"The program pointed definitely to the desirability of fairly homogeneous groupings in attempting to teach specific, definite materials."

"Once . . . sections were set up . . . curricula could be adjusted to the needs and potential capabilities of each section. . . . I am more firmly convinced than ever that this approach is a 'must' if teaching is to attain its maximum effectiveness."

" . . . experience gained will be helpful in planning the sectioning of large classes . . . it is demonstrated that . . . for a certain type of work, students at various levels of attainment can profitably be grouped together.' '

"There is no doubt but that [sectioning] recommends itself . . . where groups are sufficiently large to admit much segregation."

"This process yielded groups which if not "homogeneous' at least had similar needs and problems in relation to mathematical subject matter."

" . . . it was found desirable at this institution to group the men on the basis of their demonstrated ability in mathematics, science, and general scholastic ability."

" . . . factors . . . in our success. . . . Each class was carried on independently at the rate best suited to its ability . . . "

"The men accepted the sectioning without protest and often indicated they appreciated the attempt to place them at the proper learning level."

"Sectioning . . . was not resented by the men . . . but for the most part, welcomed. . . . [They] would rather be grouped with others of like ability and background."

" . . . better training results would have been obtained had it been possible to assign trainees to class groups according to background in sciences, native ability and high school grades . . . "

" . . . to segregate students on the basis of ability . . . would have been desirable."

"The program would have been more effective if we could have sorted the students for uniformity of background."

" . . . sectioning . . . tended to develop a defeatist attitude . . . "

" . . . a group rated low in ability is weighted down by its own load. . . . "

Remedial classes (3)

"The instructors felt . . . remedial classes were worthwhile . . . provided . . . opportunity to become better acquainted with . . . needs and weaknesses of individual students."

"Suggestion for improvement: . . . start remedial instruction periods at the beginning and . . . provide for definite remedial, individual instruction throughout each course."

" . . . individual-help sections for weak students . . . proved very beneficial. In these remedial sections, faculty members not only gave assistance in subject matter but they frequently counselled with the students about personal matters. . . . "

SPEED-UP

(25)

"During the past three years many articles have appeared in [publications] concerning the so-called 'accelerated program' under which the various military programs have operated. Acceleration in education, especially of the technical variety, was represented as a wartime necessity. Many enthusiasts have advocated a continuation of accelerated education even after peace has been declared. It is the opinion of this writer, however, that as soon as possible the accelerated program should be discontinued."

" . . . acceleration . . . showed . . . that there is a saturation point for the rate of presentation of new ideas . . . unusual success in training but not necessarily in education."

"Even a high degree of motivation . . . cannot force the individual much beyond an optimum pace for acquiring new learnings."

" . . . demands upon the men were too great to allow effective grasp of the subject matter, intellectual 'digestion' and performance on the level of real scholarship . . . "

" . . . nothing to indicate that it was possible to 'learn more in less time' . . ."

" . . . acceleration would not provide the same degree of success in building a safe foundation for education of university students in general."

" . . . not a 'speeded-up education;' it is a specialized education."

" . . . heavy loads and speed-up procedure may serve their purpose in technical training but not in education."

" . . . success in training but not necessarily in education."

"The liberal arts education attempts to give the student perspective and to develop his ability to use his mind. This cannot be speeded up—it is a slow maturing process."

"The training demanded to meet a specific military need is not the broad education we should provide under normal conditions."

"War programs . . . proved valuable to develop technicians, but a college degree should stand for more than a technician. . . . [To] speed up and streamline education . . . will narrow down the benefits in proportion."

"[Students] should have ample time . . . to mature in the field of general education and in some field of specialized study."

"The condensation process has resulted in a very definite lack of correlation or integration."

"Results obtained indicate that . . . increase in material covered per recitation resulted in a loss of absorption by the student."

"Any saving of time was at the expense of thoroughness, omission, or cultural training."

"There is a certain point beyond which loads cannot be increased."

" . . . 'speed-up' . . . should have no place in postwar planning."

"I do not recommend this feature of the program."

" . . . we can say [little] in favor of similar 'speed-up' procedures for civilian purposes."

"The longer the period of acceleration, the more unfortunate it seems to become."

"The instructors in this department would not recommend a system of speed-up. . . . "

" . . . the majority of the engineering societies condemn the practice."

"Through pressure of time we achieved a new precision, often too dogmatic . . . but at least productive of results over a relatively shorter time than those we achieve now."

"Experience in conducting an accelerated educational program, if, at the same time, standards are maintained, should prove valuable . . . especially from the economy of time and from the striving for precision in instruction and learning."

FACULTY

(22)

Education serves (13)

"The teacher was inspired by the fact that the better and faster the men learned the materials offered, the more the instructor was contributing to the success and . . . conclusion of the war. A similar spirit should be carried over into . . . college education in general. A feeling that the materials taught are effective in turning out mature citizens [better equipped] to 'fight ignorance' should be developed."

"The teachers were impressed with the importance of their job . . . this led to the free exchange of ideas, equipment and suggestions without fear of offense. It also stimulated . . . a constant effort to improve . . . teaching [technique]."

" . . . this program . . . added . . . worthwhileness to the entire college atmosphere."

"Faculty morale was remarkably good . . . the teaching contributed directly to the war effort."

"Faculty morale was extremely high. All felt the stimulation of performing a useful wartime task."

" . . . definite feeling on the part of all the instructors that they were making a real and significant contribution toward the war effort."

" . . . an important contribution to the war effort was a definite stimulus to the faculty morale . . . "

"Everyone felt the urge of the emergency and no further stimulation was necessary."

" . . . given us an acute consciousness . . . that we are making a substantial contribution to the war effort."

"The immediate satisfaction [was] represented in the knowledge that [the college]was undertaking a very important special job in the service of the nation . . . "

"The college has . . . fulfilled its obligation in aiding in the common war effort."

"The college . . . was able to discharge its wartime obligations in a highly creditable . . . manner."

"A creditable addition to the good will of the general public toward the college . . . "

An adequate faculty (9)

"Faculty morale was good throughout the program."

"Faculty enthusiasm for the [program] was excellent."

"Our instructors . . . tried to cooperate and collaborate even when this meant personal sacrifices. . . . "

" . . . the willingness of the faculty members to devote additional hours of service to the students, over and above their regular teaching jobs, was an example of the fine spirit of cooperation and service."

"As regards the excellent morale of the staff, the first factor was the able, purposeful and keenly responsible teachers [recruited]."

"The faculty had not only the enthusiasm, but also the preparation and experience necessary for the task . . . personality and possession of the subject matter have much more weight than formal training."

"Faculty members were well qualified."

"In general, academic degrees meant little. Salaries were adjusted more in accordance with personal ability and service to to the program. In short, a good teacher was more valuable than a good degree."

"Because the . . . teaching load . . . was lighter instructors were able to do energetic classroom teaching . . . and to devote time to experiment in ways of presenting material . . . scope for work and originality on the part of the instructor in shaping the course both in the classroom and in staff meetings. In short—the teacher became central."

OBJECTIVES

(13)

General (1)

"The chief lessons . . . instructors were made sensitive to certain philosophies and techniques, which they could carry over into some other teaching program."

More specific objectives (7)

"The men had clear objectives; they knew where they were going, what they wanted to do, what in general they were being trained to do. The fact, astounding in many ways after the academic generalities—that fact, it seems to me, stands back of the values to be learned from the Army program."

"As a result of the very definite objectives of [the V-5 and V-12 programs], an integration was achieved such as was seldom true of pre-war college curricula. This, together with the better student motivation deriving from these same objectives, has produced . . . better than average scholastic results . . . "

"Clarity of objectives, concern for practical essentials . . . are certainly lessons to be learned and put to profit."

"Many departments could profitably spend time in outlining detailed curricula and sequences of courses designed for specific goals."

" . . . to attain course objectives . . . courses . . . were standardized as [regards] minimum essentials. . . . "

" . . . pointing toward a definite objective . . . brought the satisfaction of working toward a common goal."

"[The program helps in] the clarification of the aims of the college in serving fully its function of higher education . . . "

General or liberal education (5)

"The training of Navy officer candidates afforded proof . . . of the vitality of the liberal arts. . . . The primary importance of this single fact for the future of liberal education can hardly be overemphasized."

"The second important lesson of the V 12 program is its demonstration of the value of the fully-prescribed curriculum as opposed to the freely elected program."

"They want something which will 'pay off.' Many . . . are thinking in . . . . . financial terms, but some . . . are thinking in broader and longer terms. They want something which will help them as individuals to live better and fuller lives, and through them, the society of which they are a part."

" . . . colleges should guard against selling their liberal arts education for a mess of technical training . . . [ours is the job] to provide . . . a basis of democratic motivation. This means a re-emphasis on the social sciences . . . on those . . . principles which have been the basis for man's social life. . . "

" . . . every publicly supported institution . . . should underwrite the health and physical fitness of its graduates not only from the standpoint of serving their country in time of war but to assure that the education . . . acquired may be utilized for the benefit of society for a prolonged period of time."

ENTRANCE STANDARDS

(11)

General (6)

"All instructors were impressed with the extent to which out-of-school experience, intelligence and motivation could compensate for lack of previous formal education."

" . . . the number of years' study, or the number of credits accumulated, is no exact measure of proficiency. Experience outside college . . . deserves consideration."

" . . . it would be well to admit men to courses on the basis of achievement tests in the prerequisite subjects, rather than on the basis of credits recorded."

"The evaluation of a student's educational background in an effort to determine his ability . . . rest]s[more upon a properly designed achievement test than in assumptions based upon the particular schools which he had attended."

"Some individuals through their out-of-school experience have acquired a maturity and competence which qualify them for admission to college. . . . Comprehensive examinations . . . should be used to determine the college status of these students."

"We should recommend that, if the achievement test be adopted as a basis for admission, the classification be subject to adjustment.. . . . "

High school background (5)

" . . . could hardly eradicate attitudes ingrained since childhood—attitudes for which the American schools are in no small degree responsible."

"More attention needs to be paid to arithmetic reasoning. . . . This would imply that mathematics teaching for general education in our high schools be straightened in the area of simple arithmetical reasoning."

"V-12 trainees [were] woefully deficient in [their] knowledge and use of grammar. There is only one other language skill in which [they] are still worse: spelling. Spelling deficiency offers the clearest clue to the basic reason for the unusual weakness of the average male high school graduate in writing.

"Coupled with the deficiency in written composition was a low reading ability."

" . . . deficiency in heading skill has been the major contributing cause to the difficulties which trainees have encountered in all their college subjects."

II

A SURVEY OF SOME COLLEGE PLANS AND COLLEGE PROGRAMS

During the last eighteen months there have come to hand six articles which reflect national, regional, and institutional experience with these military training programs. These six articles are:

1. "A Core of Liberal Education," editorial, *What the Colleges are Doing,* No. 72, Spring, 1945.
2. "A Survey of College Plans for Veterans' Education," Hoyt Lemons. (Prepared for the Veterans' Advisor's Office, Washington State College) April 4, 1945.
3. "Special Curriculum for Veterans," Charles E. Friley, President, Iowa State College. (Presented at the meeting of the Association of Land-Grant Colleges and Universities, Chicago, Illinois), October 24, 1944.
4. "Recommendations of the Pacific Northwest Conferences on the Arts and Sciences," Preliminary (May 18-20, 1944), First Annual (November 17-19, 1944), and Second Annual (December 27-30, 1945).
5. "Statement of Principles" and Unofficial Recommendations of the Northwest Regional Hazen Conference on Student Guidance and Counseling, August 5-10, 1945.
6. "Recommendations of the President's Committee' (Committee of Forty), Washington State College, July, 1945.

In the study of the military training programs in the colleges and universities of the Pacific Northwest the comments could all very nearly be grouped under six major topics:

1. Integration	(46)	Comments
2. Student Motivation	(38)	"
3. Individual Education	(33)	"
4. Speed-up	(25)	"
5. Faculty	(22)	"
6. Objectives	(13)	"

We have, accordingly, read the six sources referred to above for their comments upon these same six major topics.

INTEGRATION

What the Colleges are Doing: "The second recommendation that appears in nearly all these reports [of] plans for modifying and reshaping the curriculum has to do with the relationship established between the fields of knowledge, and the breaking down of departmental barriers."

Special Curriculum for Veterans: " . . . by consolidating subjects of nearly the same content and purpose and eliminating certain options . . . the number of undergraduate subjects [at M.I.T.] was reduced from 523 to 412. The principle aim in these reductions is to simplify the regular program."

"In the field of the humanities and social sciences there will be a small number of courses but these will be better coordinated."

"In the senior year the students will be given an opportunity to choose one of four [integrated courses], namely, the history of science and thought, music and the fine arts, western world literature, or international relations. Each of these four courses will be closely coordinated with the objectives and purposes of those given in the preceding three years."

Recommendations of the Pacific Northwest Conferences on the Arts and Sciences: "Curricular changes are needed which will achieve . . . better integration of learning."

"That . . . there be developed in each field of knowledge an integrated course, or sequence of such courses, which will present in their relations to each other, the fundamental principles and content of the kindred subjects in each . . . field."

"These courses should be so designed that they can serve the purposes, not only of general education, but also wherever possible, of introductions to specialization."

Statement of Principles and Unofficial Recommendations of the Northwest Regional Hazen Conference on Student Guidance and Counseling.[1] The real lessons in the military training programs for postwar education were:

1. A simplification of curricula.

2. A simplification of course outlines.

3. A coordination of subject matter (integrated courses and topical majors).

In orienting higher education to vocational family, community, national and world living . . . it is important . . . to take into consideration: The time when these different orientations should be made, and the motivating factors involved in these orientations.

The entering freshman is usually more nearly ready for his vocational orientation than he is for his personal or social orientations . . . a philosophy of life or social responsibilities (i.e., suffrage, marriage, and parenthood) concern him little or seem pretty distant.

These considerations lead one to conclude that while orientation [integrated] courses should . . . be offered in the freshman year, it is quite as important that others be offered in the junior and senior years.

[1] Theme: "Emphases Imperative in Higher Education in the Post War Period."

Recommendations of the President's Committee: "That the departments concerned carefully consider the setting up of [integrated] courses in . . . the Humanities, the Social Sciences . . . and the [Biological and Physical] Sciences. It is the view of the Committee that students might well acquire a broader synthesis of knowledge in and a greater appreciation . . . of learning [in such courses] than they are now able to get in the traditional introductory subject matter courses."

"That the teachers of basic courses, whether they be integrated or on the separate-subject basis, should meet regularly as scientists, social scientists, and humanists; and that the instructors in all three areas should meet occasionally for the purpose of discussing integration of materials and methods."

"That a thorough review be made of existing curricula . . . to secure better integration of courses, and the elimination of unnecessary duplication."

STUDENT MOTIVATION

A Survey of College Plans for Veterans' Education: "The time-honored motivational factors of grades, academic honors, penalties, and social values may be inadequate [requiring a] revision of teaching methods."

Recommendations of the Pacific Northwest Conference on the Arts and Sciences: "Functional instruction . . . (teaching through student application of theory in real or simulated life situations) . . . provides greater motivation . . . The student, confronted with life situations, is compelled to seek solutions himself, cannot passively memorize materials. Unskillfully used, the method runs the danger of substituting mere activity for substantial learning."

INDIVIDUALIZED EDUCATION

A Survey of College Plans for Veterans' Education: "That enough qualified instructors [be secured] to keep classes sufficiently small for work with individuals. Some institutions are already hiring additional instructors to meet the coming need."

Special Curriculum for Veterans: "The task confronting us is to provide the educational experiences which will best meet the variable aptitudes and needs of this heterogeneous group."

"All classes [at M.I.T.] will be held in small sections."

Recommendations of the Pacific Northwest Conference on the Arts and Sciences: "The employment of more faculty members in order to increase the number of smaller classes in which more intimate association of teachers and students may result."

"That, without displacing the lecture and the laboratory in the sciences, wider use be made of the group-conference method of teaching."

Statement of Principles and Unofficial Recommendations of the Northwest Regional Hazen Conference on Student Guidance and Counseling: "The curricula and the educational practices should be directed in such a way as to realize personalized education insofar as possible."

"Class size and teaching methods should be determined by the degree they permit the recognition of individual differences."

Recommendations of the President's Committee: "That care constantly be exercised to adjust classes to the most effective size."

SPEED-UP

A Survey of College Plans for Veterans' Educations "There may be considerable demand for year-round schooling by veterans because of desire to get jobs, and to receive year-round government pay."

Nebraska's Program: "A liberal policy regarding acceleration: (a) carrying additional courses where qualified; (b) full year study: (c) taking advanced standing examinations."

Special Curricula for Veterans: "It will be especially important to develop four-year curricula adapted to the needs of veterans because 'surveys indicate that 75% or more of the veterans will want work of this sort'."

"Vocational training of non-degree nature—the best estimates are that only 10 to 25% of the veterans will require courses of this nature. The danger of going too far with this type of curriculum is generally recognized. On the other hand, the land grant college is probably obligated to give a certain amount of this type of work."

Statement of Principles and Unofficial Recommendations of the Northwest Regional Hazen Conference on Student Guidance and Counseling: That irrespective of what the veteran may or may not have said before coming to college, that when he comes, he takes the regular courses. (This was the experience of the University of Washington with better than 500 veterans . . .)

That "speed-up," that much-publicized attribute of military training programs, should not be perpetuated in post-war programs except as institutions make greater use of summer sessions and allow certain students to carry heavier loads.

Recommendations of the President's Committee: "The Senate [legislative body of the faculty], on the recommendadation of the Committee on Post-war Education, has already approved at least two effective methods of acceleration, special examinations for credit and a 12-week summer session for at least the summer of 1946. The Committee feels that these constitute the only kind of acceleration it can recommend."

FACULTY

What the Colleges are Doing: "Many teachers will not be eager to submerge their own special interests or to scrap pet courses for these more general approaches to subject matter. Many others will be unable to adapt their teaching methods to the new demands imposed upon them."

A Survey of College Plans for Veterans' Education: "The principal problems to be faced: . . . Securing enough qualified instructors to keep classes sufficiently small for work with individuals. Some institutions are already [April, 1945] hiring additional instructors to meet the coming need."

Special Curriculum for Veterans: "If the needs of this new student body demand that some of our traditional educational machinery and procedures should be scrapped, then it should be done as willingly in peace time as in war."

Recommendations of the Pacific Northwest Conference on the Arts and Sciences: The "employment of more faculty members in order to increase the number of smaller classes in which more intimate association of teachers and students may result."

"These tasks will require a great expansion of the resources and personnel of the institutions of Higher Learning. . . . 'Anything less than this means we shall be denying at least some Americans the kind of world they have fought for'."

"That a staff of teachers who have training, temper, and enthusiasm for this method of instruction [integrated courses] be built up."

Statement of Principles and Unofficial Recommendations of the Northwest Regional Hazen Conference on Student Guidance and Counseling: " . . . all members of the faculty have a role and responsibility in the program [of counseling]."

Recommendations of the President's Committee: "The common factor in developing an intellectual center, a great research institution, a socially conscious student body and public, and a useful extension service—in the opinion of the members of the staff who replied to a questionnaire on this subject, and of the Committee—is a competent faculty."

OBJECTIVES

What the Colleges are Doing: The "reorganization of college education must go much further than a reshuffling of subject matter. It must involve a new conception of the end and aim of higher education, of the relation of general college education to the life of . . . man . . . the citizen in a democracy."

"It would seem that our shortcomings in college education have now been generally recognized, and we have determined to correct our errors before this education falls into disrepute."

"Never before, perhaps, have American colleges been so busy with plans for modifying and re-shaping the curriculum. Two main causes may be found for this soul-searching: the impact of the army and navy training programs upon the old divisions of studies with their frequent lack of specific objectives, and the urge to adapt the courses of study to the needs of the returning veterans. The conclusions reached by most of [the colleges] are strikingly similar."

" . . . all students in the first two years of college, irrespective of their plans for later specialization, will be expected to pursue certain studies that make up 'a core of liberal education'."

A Survey of College Plans for Veterans' Education: A new emphasis "on general education."

"Many institutions are delaying the beginning of the major until the end of the sophomore year. This delay of the major has been announced at Massachusetts Institute of Technology, University of Nebraska, South Dakota, Yale, and others."

Special Curriculum for Veterans: "The new schedule [at M.I.T.] . . . provides for a standard curriculum for all first-year students. The second-year curriculum has been divided into two main divisions, science and engineering, with an opportunity given the student to begin the elementary subjects of his chosen profession."

Recommendations of the Pacific Northwest Conference on the Arts and Sciences: "The part of the college program which at the moment seem[s] to . . . [be] . . . most inadequately meeting conditions and needs is the so-called general, preferably basic, education."

"We believe that the basic or general education of the college student should normally be offered in the freshman and sophomore years and that it would be desirable and necessary to postpone the choice of the major until the end of the freshman year at the earliest, preferably not until the end of the sophomore year."

Statement of Principles and Unofficial Recommendations of the Northwest Regional Hazen Conference on Student Guidance and Counselings: That colleges mature long-range programs that are postulated upon the ultimates in education and that they eschew short-range programs that only reflect the immediate needs of the student (veteran or non-veteran).

The election of the major should be postponed until the end of the freshman or perhaps the end of the sophomore year.

Recommendations of the President's Committee: "That more liberal requirements for graduation be adopted."

"That the formal election of the major be made at the end of the sophomore year, except in those professional and technical departments which, in the judgment of the Curriculum Committee, require specialization from the beginning." This recommendation is made in the belief that "the present system has fostered overspecialization . . . and a consequent failure [of students] to acquire an adequate general education."

III

CONCLUSIONS

INTEGRATION:

From the foregoing data on The Military Training Programs in the Colleges of the Pacific Northwest and from A Survey of Some College Plans and College Programs it becomes apparent that an important lesson in the military training programs was integration. Integration may be achieved, as these programs have demonstrated, by more democratic administrative procedures, achieved at the expense of administrative and faculty time; by frequent faculty meetings, achieved at the expense of faculty time, and by closer supervision also achieved at the expense of faculty time. Integration is not impossible to have in our colleges, but it has its price—an adequate faculty.

Administrative and faculty adjustments and reorganizations in the interest of integration are helpful and dramatic, but they do not get at the source of the trouble —an inadequate faculty.

STUDENT MOTIVATION:

Another lesson was that the student must be allowed to participate in his own education to a greater degree than heretofore.

The lecture system, generally speaking, seems poorly designed to inspire much student participation, but to correct the abuses of the lecture we shall need larger faculties.

The lecture system, generally speaking, appears to be something less than the best instrument to inspire real student participation, but to replace the textbook with source books and actual experience with materials the student needs more direction, and more direction means a larger faculty.

The laboratory, similarly, can only become the fine educational experience that it can be when the problem method is more generally used, but this requires an adequate faculty.

INDIVIDUALIZED EDUCATION:

Individualized education is realized only in small classes and in techniques of instruction and counseling which are sometimes described as uneconomical of faculty time. Actually, there is nothing quite so uneconomical of faculty time as large classes, because an instructor cannot do much educating in a large class.

While counseling requires some experts, most of the counseling on any campus is done by the faculty, and whether that counseling is good, bad, or indifferent depends very largely upon whether that faculty is able to give, or is willing to give, its time and its interest to the task. A college cannot buy better counseling with one or two appointments: it has to pay the price—an adequate faculty.

SPEED-UP:

Even speed-up has its implications for the recruitment of college faculties. As Henry S. Sigerist, of the Johns Hopkins University, has said (*Science*, May 9, 1945):

> "It is undoubtedly true that industry can afford to pay much higher salaries and sometimes also to provide better research facilities. I think, however, that universities . . . will still be able to attract first-rate scientists, not with money but by offering them time and leisure, the stimulating contact with students . . . the inspiring intercourse with colleagues from other faculties . . . the long summer vacations that permit them to travel and continue their work in other institutions and countries. . . . "
>
> "This presupposes, however, that universities have the courage and vision . . . to resist trends that tend to turn them into speed-up, high-pressure schools with purely utilitarian purposes. No serious researcher will accept the position as head of a university department, if he knows that he will be crushed with petty administrative duties or with a load of routine teaching. Men should not be selected to fit a job, but the position should be made to fit the man, because it is not regulations and curricula that constitute higher education but the man to whose influence students are exposed."

FACULTY:

We know what should be done and we know how to do it, but are we doing it? Sometimes it seems as though we work all around the problem. We organize and reorganize administrative staffs, faculties, and curricula. We develop building programs; more space and better equipment. We advance plans for better libraries; more books, and better facilities, but some colleges still do not seem to realize that the primary problem is a more adequate faculty. These other concerns of the college are real enough and are, of course, important, but they are secondary.

OBJECTIVES:

From the data assembled in this paper it becomes apparent that educators are generally agreed upon objectives, namely, that it is the task of the college to provide better "general education," i.e., more "liberal education." Disagreement as to these objectives is apparently a local phenomenon. Furthermore, it would appear that where disagreement exists, it exists primarily because the administration or the faculty is uninformed or unconvinced, and to remain unconvinced on this subject would appear to be largely a matter of being uninformed. To be uninformed can only mean that the administration or faculty is too busy to inform itself about curricula practices at other institutions, or what it more likely, is not interested in informing itself. In either event, it adds up to the same thing—a staff that is inadequate (inadequate as to numbers or in its knowledge of its responsibilities).

IV

SUMMARY

"What Were the Lessons in the Military Training Programs for Education?"

The lessons can be quickly and simply shown by a score sheet in which the general and inclusive lessons (in bold face) and the more specific and limited lessons (in italics) are listed. This analysis may even be made quantitative by totaling the number of comments made upon each lesson, be it general or specific.

Integration ..... **(46)**
- *General* ..... (9)
- *Examples of* ..... (9)
- *By democratic administrative practice* ..... (13)
- *By frequent faculty meetings* ..... (9)
- *By closer supervision* ..... (6)

Student motivation ..... **(38)**
- *General* ..... (4)
- *Wartime incentives* ..... (10)
- *Relevance* ..... (9)
- *Participation* ..... (6)
- *Audio-visual aids* ..... (5)
- *Competition* ..... (4)

Individual education ..... **(33)**
- *General* ..... (16)
- *Sectioning* ..... (14)
- *Remedial classes* ..... (3)

Speed-up ..... **(25)**

Faculty ..... **(22)**
- *Education serves* ..... (13)
- *An adequate faculty* ..... (9)

Objectives ..... **(13)**
- *General* ..... (1)
- *More specific objectives* ..... (7)
- *General or liberal education* ..... (5)

Entrance standards ..... **(11)**
- *General* ..... (6)
- *High school background* ..... (5)

An adequate faculty:

Until our colleges realize that their faculties must be increased by a quarter, or a third, or more over their pre-war number, the primary lessons of the war and of the military training programs have not been learned; at least, are not yet practiced.

The opponents of the colleges:

It is not too late, but it is getting late. Our colleges will house and feed their thousands, but if these data mean anything they mean that the colleges will not be able to educate these thousands as they should (we are in almost complete agreement on objectives); and as they can (the military training program proved this)—unless they and their public bend their every effort to the development of adequate facilities.

THE OPPORTUNITY OF THE COLLEGES

W. R. HATCH

State College of Washington[1]

Our pre-war brand of education did not stop World War II and that same kind of education will not stop World War III. But perhaps this is unfair; perhaps education should not be held responsible or accountable. If education cannot seriously affect the course of human events, however, it should stop pretending that it can and society, in turn, should stop pouring its resources into education and look for a more effective instrument.

In times like these one becomes suspicious of heroics, but it will take heroic measures if we are to do the job we have to do. We have the specifications (there is almost absolute agreement on objectives[2]), we have the "know-how" (the college military training programs proved this), but we do not apparently see our moral responsibilities, and, worse still, we do not apparently believe in ourselves or in our destiny; we do not see our opportunity.

In the fall of 1944 I talked with enough veteran-students to sense that education's great opportunity was upon it. I set my ideas down in a little article with a long title "What Our Students in Service Are Thinking About: Its Bearing on Education." At about the same time a captain in the Medical Corps attached to the Army Air Forces Regional and Convalescent Hospital at Fort George Wright—Captain B. N. Tager—came to the same conclusion that I had reached. It was Captain Tager's job to find out what was happening to thousands of sick and well G. Is, and he was driven by what he saw that he not only wrote "Mission for College Education," but came to Washington State College to argue his case before its new president and its faculty. It was his hope that the College might develop a program that would realize this mission. More recently, in January, 1946, a Scripps-Howard staff writer—J. G. Lucas, who had been a lieutenant in the Marine Corps and had seen action from Guadalcanal to Iwo—discovered in himself some of the things that Tager and I had seen in the veterans. The Lucas article was entitled "Nostalgia For War." These three articles are abstracted and compared on the following pages.

---

[1] Head, Department of Botany.

[2] See, "An Experiment in Education: the College Military Training Programs," pp. 66, 73, and 75.

"WHAT OUR STUDENTS IN SERVICE ARE THINKING ABOUT: ITS BEARING ON EDUCATION," W. R. Hatch, *Education, June,* 1945.

BASIC IDEALS

"The experience of our students in service, but particularly of those who were overseas, has been that it stripped . . . the cataract of materialism . . . from their eyes. Their discovery that money and a life spent making money do not 'pay off' when the chips are down or at any other time for that matter, could mean that a college education that justifies itself to the student in terms of the pay check it will ultimately provide, will not justify itself to them."

"Their interest in human values . . . also has implications for the educator because it could mean that a college education that loses sight of these values, the values that give dignity to man and give meanting to his society, is not the kind of education they found 'right and needful'* in their slit trenches."

THE SOCIAL GOOD

"Their discovery of the importance of citizenship, democracy and freedom could mean that a college education that has not made this discovery or at least does not reflect it, may seem cloistered, unreal and possibly unimportant."

FRUSTRATION

"Of course this thing that has happened to the service man . . . is not permanent. He can slip back into his old way of thinking . . . very easily, but with this difference: he is very likely to feel a blind and choking sense of frustration. He may not know who or what is to blame, but he will know that something fine and something good went out of his living when he came home; and he may hold us, the educator, along with the rest of society, responsible. . . . If we are cynical and un-understanding . . . the only positive good that this war might have produced will be lost, and in this loss the soldier will have learned to hate society, and society to hate itself."

*Anonymous, "Open Letter to My Wife," The Saturday Evening Post, March 25, 1944, page 34.

"MISSION FOR COLLEGE EDUCATION," Capt. B. N. Tager, *Review*, A.A. F. Regional Convalescent Hospital, Fort George Wright, July, 1945.

"Times of war generate in the services and population at large a groundswell of unselfish devotion to a common cause, an affirmation of basic ideals."

"Some adaptation both in the mechanics and the objectives of our educational system . . . is necessary for the mobilization of our society for the greater social good."

"War like any misfortune or illness generates an excess energy which if harnessed to our ideal holds the promise for an enriched life for the individual and a national renaissance, but if permitted to go unharnessed leads to frustration, escape, and cynicism, i.e., religion turned sour."

"NOSTALGIA FOR WAR," J. G. Lucas, New York World-Telegram, January 14, 1946. (Condensed for *Readers' Digest*, April , 1946.)

"We say that the men who fought this war . . . hate war . . . But it isn't true . . . When I asked myself recently, 'Do I hate war?' I had no answer, 'I don't . . . Selfexamination shocked me; I suddenly was aware of something I hadn't known about myself. I suspect that more of the millions who fought this war feel this way than admit it, even to themselves.

"War is ugliness. War is death. War is destruction. War is heartbreak and sorrow. The men who fight wars, when they fight them, hate war . . . But when wars are over . . . that's easier to forget.

"You don't forget the other side of war. You don't forget that in war you found the only Christian brotherhood you ever knew. You don't forget that in war you found complete selflessness. You don't forget learning in war that a man could love the other fellow more than himself, if only for a minute, an hour, a day. You don't forget that in war you saw men who loved life give their lives for you."

"I didn't know that kind of living before I went to war. I haven't known it since. I miss it. The absence of it, the brutal contradiction of it in peace, makes it harder to forget. Living on that plane for an hour, I am dissatisfied with anything less."

"Our task is at once simple and staggering. We've got to forge a world of peace out of the same steel we forge a world at war. It's insane that war should bring out our best qualities and peace our worst."

	"WHAT OUR STUDENTS IN SERVICE ARE THINKING ABOUT: ITS BEARING ON EDUCATION," W. R. Hatch, *Education, June,* 1945.
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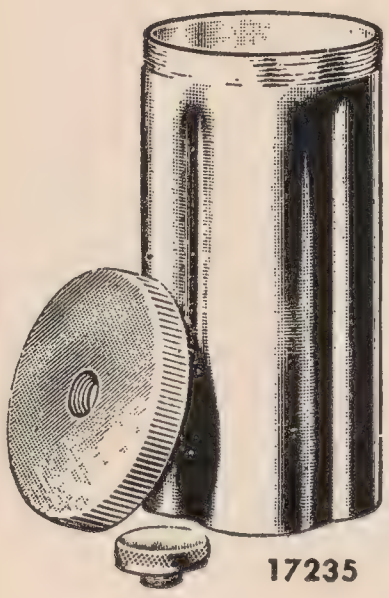

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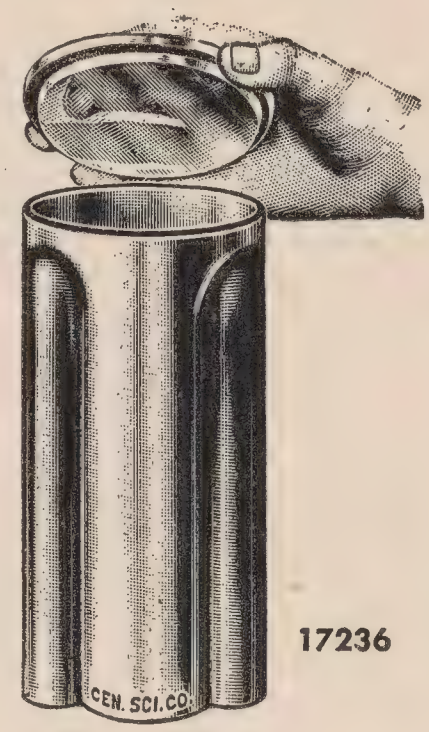

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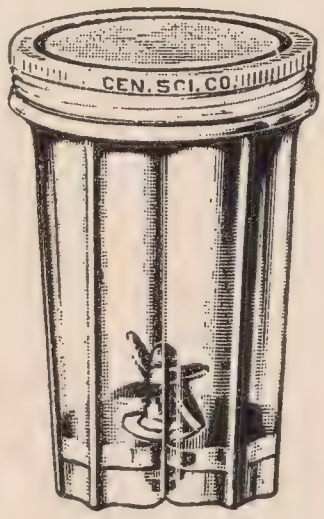

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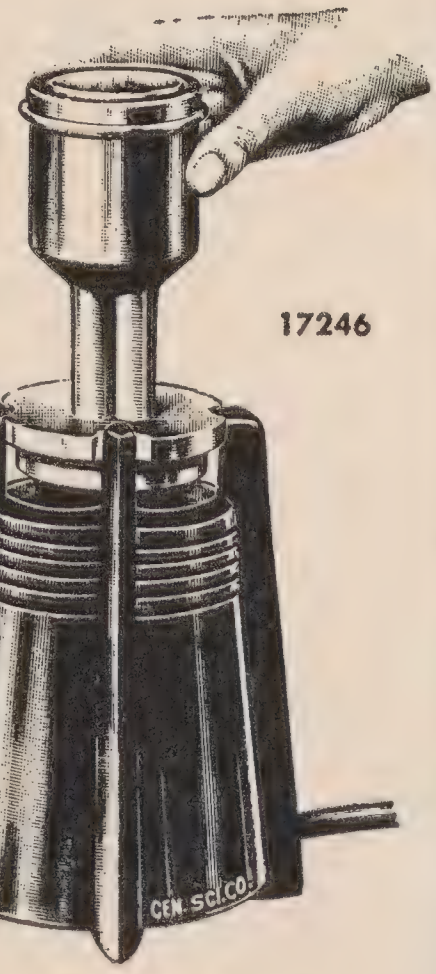

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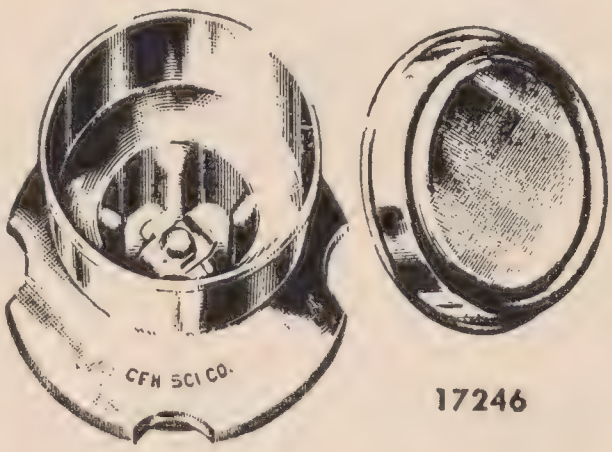

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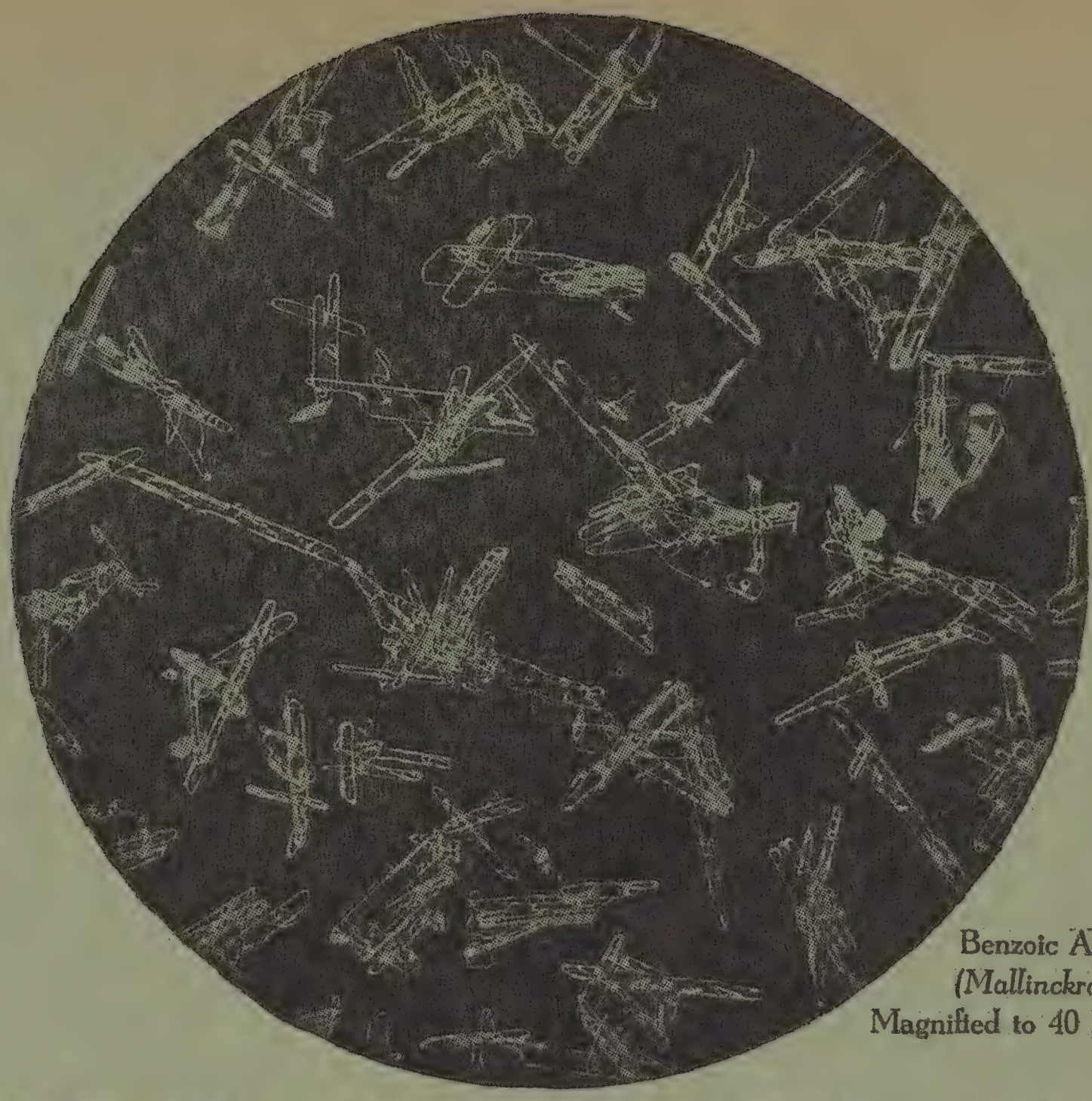

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Entered as Second Class Matter, April 5, 1927, at the Post Office, Cheney, Washington. Office of Publication, Cheney, Washington. Subscription price to members, including dues, two dollars per year; to non-members, two dollars. Single copies sixty cents each. Volumes I to XX, 1927 to 1946, each $1.25. All nineteen volumes, $20.00.

Illustrations and tabular matter together should be limited to approximately twenty per cent of the total number of pages. Authors will be charged at cost rates for illustrations and tabular matter in excess of that amount (approximately $4.70 per page for tabular matter, and approximately $8.10 per page for cuts.)

NORTHWEST SCIENCE

VOL. XX, NO. 4 NOVEMBER, 1946

Published December 3, 1946

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R. A. Diettert, Department of Botany, Montana State University, Missoula, Montana

H. F. Gauss, Department of Engineering, University of Idaho, Moscow, Idaho

H. W. Lundy, Head, Health Education Section, State Department of Health, Seattle, Washington

Rev. T. O'Leary, S.J., Department of Chemistry, Gonzaga University, Spokane, Washington

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H. Tascher, Department of Economics and Sociology, Montana State University, Missoula, Montana

The Editorial Board is made up of the sectional chairmen. Since an editorial board is something new and its constitution may not be understood we are listing the persons named above as Sectional Chairmen of the Association.

SECTIONAL CHAIRMEN OF THE NORTHWEST SCIENTIFIC ASSOCIATION
1946

Botany-Zoology	R. A. Diettert
Chemistry-Physics-Mathematics	Rev. T. O'Leary
Geology-Geography	P. E. Church
Bacteriology-Public Health	H. W. Lundy
Engineering-Industrial Sciences	H. F. Gauss
Forestry	K. P. Davis
Soil Conservation	J. L. Schwendiman
Social Sciences	H. Tascher

ANNOUNCEMENT OF ANNUAL MEETING

The annual meeting of the Northwest Scientific Association will be held as usual, at the Davenport Hotel in Spokane, December 27-28. These meetings are regularly attended by members of the Northwest Scientific Association representing all fields of science, who assemble from the four northwestern States, but they are open to all who may be interested.The importance of this annual convention to scientists of the region has recently been underscored by the University of Montana, through the adoption of the policy of paying travelling expenses of those scientists on the faculty who attend the meetings.

Those who wish to present a technical paper at one of the Sectional Meetings should get in touch with the Chairman of the appropriate Section. On the opposite page the Sectional Chairmen are listed separately and as members of the Editorial Board.

In addition to the researches described at the Sectional Meetings there will be a few outstanding speakers who will address the entire group on broad subjects of special interest to scientists of the Northwest.

Programs listing the speakers and their topics will be distributed to members of the Association early in December. Others may obtain copies at the meetings, or earlier by addressing their requests to me.

R. F. Daubenmire, Program Chairman
Department of Botany
State College of Washington

PRESIDENT'S MESSAGE

At our last annual meeting many of our members were not yet fully readjusted to civilian life and our organization was not yet reconverted to peacetime activities. Nevertheless we held a good meeting and most of the Sections got their feet firmly planted on the ground.

This year we should see our opportunities and responsibilities far more clearly. Our returned military members must now be ready to make their influence felt. Our stay-at-home members likewise recognize the responsibilities of the Association better than before. By combining their efforts and coordinating the activities of the eight Sections into a better integrated Association we can help our region and perhaps even influence national trends. Several new developments of both regional and national interest are to come up at the annual meeting.

An association like ours has several *different* roads it could follow. Our Association officers are aware of this, but the choice should be determined by the membership at large. Our annual meeting offers every member his or her chance to influence that choice. Crabbing and growling to your buddy or co-worker is all right, but standing up in meeting and telling the Association what you think is more likely to produce the kind of an Association you want.

We are then set to go—into the doldrums or cross-country like a big High-Pressure area. The choice is yours.

H. T. Gisborne, President

NOTICE TO COUNCIL MEMBERS: The Council will meet at 8:00 p.m. *December 26*, in the Davenport Hotel on pre-meeting business.

DEC 16 '46

THE NORTHWEST'S MARCH OF SCIENCE

WILSON COMPTON

President, State College of Washington

At the University of North Carolina last May was held a series of conferences in celebration of the 150th anniversary of the founding of the oldest of the American state universities. All the states of the South were represented. I was invited to make its opening address. The central theme of the conference was "Research and Southern Welfare." In opening its unique program, I made this statement:

> "During the last half century in the United States, more than one-half of our new national wealth has come from new ideas which were not known fifty years ago or at least were not applied to the production of things. But for the South as a whole, like the Pacific Northwest, that proportion has been less than one-tenth. This contrast is something for the South to think about."

Also it is something for the Pacific Northwest to think about. Early this year, Fortune magazine gave almost an entire issue to the far West. Its leading editorial was entitled, "Why the Pacific Coast?" Here is a part of that editorial:

> "Any time is a good time for talking or writing about the Pacific Coast. This is true partly because a profligate nature made the Pacific Coast a fabulous place; partly because life there is still *terra incognita* to most Americans. * * * For decades the West yearned for industrialization, and nursed the conivction that only a greedy colonial-minded East stood in the way. * * * Today the question whether the West should industrialize is academic. For better or worse it **is** industrialized,—primarily to ships and planes, to be sure, but industrialized nonetheless. Industrialization is not a reversible reaction; industrial communities cannot be scattered like flocks of pigeons,—certainly not in the West. * * The West now has an industrial population that only industry can employ."

Thurman Arnold, a picturesque westerner, former mayor of Cheyenne, later Professor of Law at Yale University, then Assistant U. S. Attorney General, then a Federal Judge but always a valiant gladiator, orthodox of economics and picturesque of speech, speaking five or six years ago on "Monopoly and the South" carried the idea still farther in these words:

> "The industrial East has been the Mother Country. The South and West have been the Colonies. The Colonies have furnished the Mother Country with raw material. The Mother Country has been exploiting the Colonies by selling them manufactured necessities. The industrial East has been the principal source of both capital and organization to develop the South and West. Under such conditions it has been natural enough that the South and West have been developed in the way which would contribute the most to the domination of the industrial East. This is the age-old principle of Colonial Empires."

This is a mild impeachment which neither the South nor the West may relish. But even more than its germ of truth is its challenge. Of Britain it has been said and is still said, "Export or die." Of the South and the West it may equally be said, "Utilize, conserve, and diversify, or be content with a second-rank position in the American economy."

Some people dislike the description of the West as "Colonial." But if it is a correct description, there is little gain in using different words which mean the same thing. There is nothing wrong with a Colonial status. Only it is not a very high ultimate objective for an ambitious people. It should rather be regarded as a way-station. If the principal financial, transportation, and industrial institutions in the Pacific Northwest are dominated as they are freely

said to be dominated by Eastern or Midwestern origins or ownership, and if they follow a course consistent with the interests of those origins and ownerships, they are doing exactly what should be expected of them and what they should do. In so doing, they will continue to build a stronger and gradually a more diversified economy in the Northwest.

But it will *continue* to be predominantly a raw materials economy and will be based more on development of resources in men's *hands* than on development of ideas in men's *minds*. This, although a high goal, is, I think, not the highest goal of which the Northwest and its progressive, industrious, and ambitious people are capable. The Pacific Northwest needs *ideas* of its own more than it needs *resources*. It has enough resources, if it uses them.

The Pacific Coast in the years ahead is confronted by much the same kind of opportunity looking across the *Pacific* as has confronted New England and the Atlantic states looking across the *Atlantic* for so long that it almost takes for granted that the focus of industry in this country is logically, permanently, and almost by constitutional ordination, located in the Northeast. That may be so. But I am not too sure. Time only will tell. It took hundreds of years to make New England. In an era of atomic energy with limitations of time and space almost annihilated, it will not take hundreds of years for a counterpart of New England in economy and culture to be developed in the Pacific Northwest if such a counterpart is, in fact, to be developed.

During the past century or more, our American foreign policy, if it may so be called, has been dominated by the "Monroe Doctrine." Behind this has been a purpose to preserve the security of the Americas, peace in the Western Hemisphere,—so that the American experiment in democracy might have a chance. We need no recital of the course of history which has brought this country to a position of general good will among the Americas and of recognized predominant economic strength, if not political prestige, throughout the world.

I am not a prophet. But my guess is that our trans-Pacific relations will become as dominating in the century ahead as have been our trans-Atlantic relations in the last century; and, whereas the Monroe Doctrine has heretofore been a dominant note, that in the course of time a "Strong China" will become equally dominant as a fundamental motive and objective of our trans-Pacific relations.

This may seem remote from the interests of science in the Northwest. I think it is not at all remote. If we have learned anything from history in our generation, it is that if trade and travel do not freely cross international boundaries, armies will. China ultimately is the key to peace in the Pacific; peace is the key to commerce in the Pacific, and commerce in the Pacific is the principal key to an economy and a culture of its own in the Pacific Northwest. China,—not Russia, not India, and not Japan,—is the key to the future in the Pacific. And when Chinese scientists and engineers visit Grand Coulee Dam and announce a project in China of a hydroelectric power and irrigation development several times the magnitude of Grand Coulee, let us not dismiss it as a hoax of Oriental imagination. I expect to live to see exactly that kind of development in China. It will be no more extraordinary than have been the giant achievements during the last quarter century in Russia which after the last war was so confidently described by so many willing commentators as being of a peasant people incapable of the arts of industry. If that had been so, Russia would not be where Russia is today. Neither would we.

Much has been written and more has been said about the wealth of the Pacific Northwest in natural resources, in forests, minerals, soils, waters, and electric power. The great extent of these resources is, of course, one of the finest promises of the West. But these resources are more of the nature of interesting statistics than of vital factors in American life until we learn to make more use and better use of them. The West is rich in natural resources. It is not yet comparably rich in ideas and in opportunities. That in my opinion, is the

challenge to the March of Science in the Pacific Northwest.

I am well aware of the West's so-called economic limitations,—familiar and even somewhat threadbare,—its small consuming population, great territorial expanse, distance from principal markets, lack of good roads, high transportation costs, lack of investment of capital, and comparatively high cost of venture money. All these are important, and for a long time, they will continue to be. But they are not decisive unless we think they are.

I was interested last spring in a striking pre-war comparison between the economy of the Old South and the economy of the newer West. Machinery is as good an example as any of a broad classification of fabricated industrial production. The South, for example, has about 30% of our national population. It uses nearly a fourth of our national product of machines of all kinds, but it produces less than 5%. The Western states have less than 15% of the population, use nearly 15% of the national product of machinery and produce less than 2%.

The war has brought into the Pacific Northwest great industries for the partial processing of the so-called light metals. But with the exception of a single rolling mill and of a great aircraft works, its participation in light metals has been practically confined to the production of pig or ingot metal, providing about three days' work for one man per ton. But the same metal, shipped to factories in the Middle West and the East for refinement, processing, and fabrication in forms, shapes, extrusions, tubing, forgings, and castings, has provided on a national average, nearly 45 days' work per ton; and in some limited areas in New England, nearly 100 days' of employment per ton. The Northwest would not have been able to do even this had it not been for the availability of abundant hydroelectric power at costs about 30% of the average costs of power available for the same purposes elsewhere. But with each pound of pig aluminum shipped elsewhere for fabrication and refinement went the equivalent of 3c or perhaps 4c of the Northwest's power advantage.

Down in western Oregon near Eugene is nearing completion a war plant of the Willamette Valley Wood Chemical Company. It is located in the center of Oregon's principal sawdust piles. It is the first major effort in this country toward the chemical conversion of sawmill wastes, using a process of wood hydrolisis, originated on the continent of Europe which even before the war had transformed many of the wood industries of Germany and provided the German Reich with much of the backbone of its war industries, ranging from synthetic rubber for its motor cars to high protein content feeding yeasts for its impoverished cattle.

We are all aware of this Oregon adventure. But few of us perhaps are aware of its fundamental and potential *significance,* in the forest economy of this country. What do you see when you look at a pile of sawdust? Most people grown up in the shadow of sawdust piles, when asked that question, regard it as a bit silly. Not so scientists who see the future of forest industry as much in the chemist's test tube as in the sharp saw. From a ton of ordinary sawdust in our familiar Northwest woods may be recovered over 1,100 pounds of wood-sugar capable, in turn by simple process, of conversion into the myriad of products which may be derived from carbohydrates. Taking dry sawdust at $4.00 a ton and dry wheat at $1.00 a bushel, it would take nearly $8.00 worth of wheat to provide the amount of carbohydrates which by this neo-Scholler process may readily be recovered from a dollar's worth of sawdust.

But this, too, may be merely an interesting statistic. Perhaps it is. A little more time and a further March of Science will tell. But if it is more than an interesting statistic, its significance for the United States is in this simple fact: Today the total annual wood waste in logging operations, in mills and in factories is sufficient to produce recoverable sugar equal in tonnage to the entire annual product of sugar of all kinds from

all sources; the world over, namely, 33 million tons.

Meantime the forest industries of the United States as a whole are utilizing on the average not more than 40% of the tree volume, compared with over 75% in the Scandinavian countries with conditions somewhat comparable to our own, and with nearly 85% in Central Europe before the war. Our American forest industries with the aid of better tax laws and with better public and private cooperation are in the early stages of what I hope and believe will be a great nationwide adventure in permanent forest production. Think of the impetus to forestry which would result if this Oregon adventure works out successfully. Potentially it may remake forestry in this country and particularly in the Pacific Northwest with its large percentage of lands useful for no other known purpose than forest growing.

A similar story might be told of the billions of tons of dolomite and magnesite and alumina-bearing clays under our feet and generally regarded as "dirt." Montana of the Pacific Northwest states is, I understand, regarded potentially as the richest in minerals. Idaho seems to lead in the extent of its irrigated lands. Oregon has the most extensive forest resources; Washington, certainly the most abundant power and perhaps the most convenient access to the Pacific and the Orient. But all these states have a wide common denominator or interest in terms of natural resources and in terms of intelligent, forward-looking, and ambitious people. These adventures toward the conversion of great resources into an economy and a culture of its own in the Pacific Northwest will not, I think, be accomplished without a March of Science.

I have been much interested in the scientific "tools" with which different regions of our country have to work. Among the most important tools are the industrial research laboratories. It is not known what the war has done to these. Undoubtedly there are more research laboratories than there were before the war, and many of them, on the fringes of adventure into atomic energy, are engaged in vast new fields of exploration. In 1940, there were in the United States a few more than 2,600 industrial research laboratories. In the whole of the South, as I recall, there were fewer than 150. In the whole of the Pacific Northwest there were scarcely 50. In the single state of New Jersey there were over a hundred and in little Connecticut there were 92.

The National Research Council in the late thirties estimated that there were in the United States 44,000 of what it called "research" scientists and of these only 10% were on the Pacific Coast. Whatever be the significance of these comparisons and contrasts, it seems to me that it is at least fair to assume with respect to the Pacific Northwest that a "March of Science," if its tempo is to be increased, must be initiated, stimulated, and largely guided by the colleges and universities which have and no doubt will continue to have on their faculties, not only fine teachers, but ingenious research men who are not afraid of fantastic ideas. In many fields, such as the mineral industries, forestry and agriculture, the scientific agencies of the United States Government are making an invaluable contribution. The largest responsibility, will I think for a long time continue to fall on public scientific agencies, such as the institutions of the Federal Government and the State Colleges and Universities.

The facilities of most of these institutions individually on the whole are excellent and are constantly being extended. But the present facilities, for *coordination* of scientific research even on the bare level of convenient exchange of scientific ideas are pitifully deficient. I think it is little short of absurd for Washington and Oregon, for example, to be dealing as aggressively as they are now dealing with scientific approaches to such fundamental matters as forest products utilization with as little provision as now there is for exchanges of ideas, clues, and developments. I might say that even within the State of Washington there is a sufficient problem of such exchanges between the State University and the State College. Although I am a newcomer, I recognize

the practical necessities, if not the conveniences, of state lines of demarcation. But I frankly think, with respect to the great promise of economic development in the Northwest, that our several institutions would each make a much more useful contribution to that objective if we were less conscious of, and less scrupulous about state lines in our exchanges of science and research, and if we were to confine more of our interstate and inter-institutional rivalries to the 50-yard line in the fall.

Be that as it may be, we lack the mechanism of research coordination in the Northwest among states having similar and to a large extent comparable resources and opportunities for development. Possibly a voluntary agency like the Northwest Scientific Association might provide the necessary link for such coordination and exchange of ideas. Or perhaps it might be done through some form of voluntary unofficial interstate cooperation established for that purpose. Possibly it might be added to the functions of the Northwest Governors' Conference. If not, it should be undertaken by, and if need be imposed upon, some appropriate Federal agency with Pacific Northwest regional interests or upon some regional "authority" if one is established.

I am sure that Washington State College would gladly join with its sister institutions in the Pacific Northwest in any reasonable plan for the exchange of scientific ideas and coordination of scientific research. Such a coordination I am sure can be beneficial to all Northwest scientific institutions if, as is confidently expected, there is developed as a measure of national policy a program of Federal research funds to be administered by a competent representative Federal Board to institutions competent in the widely ramified fields of science. In any event, such a cooperation would enable the work of each institution to count for more and that in itself is a sufficient justification. I hope this Association will interest itself in that objective.

Within its own field, the Board of Regents of Washington State College, as many of you know, has established what is known as the "Washington State Institute of Technology," together with a comparable "Institute of Agricultural Sciences," to coordinate, integrate and extend the functions of the institution in these fields of theoretical and applied sciences including alike teaching, engineering, research, and extension. The Washington State Institute of Technology includes the College of Engineering and its Engineering Experiment Station; the School of Mines, now called the School of Mineral Industries, and its Mining Experiment Station. Also it includes the newly established Division of Industrial Research and Extension which has an ambitious program of research, fortified by an extension service for the aid of industries, including potential small industries. This program in research and extension ultimately will be comparable in objectives if not in scope to the familiar combination of Experiment Stations and Extension Services in the field of the Agricultural Sciences.

Along with this the Institute of Technology, the Regents have announced, has been authorized to expand its undertakings to include the field of atomic power engineering. Washington State College is now engaged in an effort promptly to implement these authorizations with the best scientific directing talent available in or available to the Pacific Northwest. In so doing, in collaboration with other scientific institutions,—State, Federal and private,—it hopes that it may be able to do its fair share toward what I have called the "March of Science" in the Pacific Northwest.

FOREST SUCCESSION IN THE McDONALD FOREST, WILLAMETTE VALLEY, OREGON[1]

F. LeRoy Sprague and Henry P. Hansen[2]

U. S. Forest Service and Oregon State College

INTRODUCTION

The Willamette Valley of western Oregon lies within the cedar-hemlock climax of the Coast Forest (Weaver and Clements, 1938). The two chief dominants of this formation, western hemlock *(Tsuga heterophylla)* and western red cedar *(Thuja plicata)*, however, are not common in the Willamette Valley. Their scarcity may be due to the low summer precipitation. The mean annual rainfall is about 42 inches, which is greater than in many parts of the Puget Sound region, where both of these species are abundant and maintain their climax status. The Willamette Valley has a modified marine climate because of its proximity to the Pacific Ocean about 50 miles to the west. Less than 25 per cent of the annual rainfall falls from May to October inclusive, with little or no precipitation from the middle of June to the middle of September (Climatic Summary, 1930). The Willamette Valley is classified as having a humid, microthermal climate, with inadequate summer precipitation (Thornthwaite, 1931). It lies within the Humid Transition life zone (Merriam, 1898). Pollen analyses of sedimentary columns indicate that hemlock has never been abundant in the valley during postglacial time (Hansen, 1941, 1942, 1945).

Douglas fir *(Pseudotsuga taxifolia)* and Oregon white oak *(Quercus garryana)* are the most common tree species throughout the area. Lowland white fir *(Abies grandis)* is locally abundant on moister sites. White oak persists in dense forests chiefly as old, large, decadent, relict specimens. In more open areas, it may occur in young pure stands or in association with Douglas fir, which gradually replaces it as the forest canopy closes over. Other hardwoods of this area are bigleaf maple *(Acer macrophyllum)*, Oregon ash *(Fraxinus oregona)*, red alder *(Alnus rubra)*, and cottonwood *(Populus trichocarpa)*. The last three species occur chiefly on floodplains. On the south slopes of the Coast Range foothills, grassland areas are prevalent, but these are being invaded by oak and Douglas fir. Most of the valley floor is cultivated, but scattered groves of oak and Douglas fir are present.

Settlers in large numbers first migrated to the Willamette Valley from 1945 to 1855, and hearsay assigns great fires to this period. Prior to that time the Indians are said to have burned the country repeatedly to facilitate game hunting and to maintain various plants for food. David Douglas on September 27, 1826, wrote in his journal as he botanized from a camp 58 miles up the Willamette River, that there was hardly a blade of grass unburned except along the fringes of the streams (Morris, '34). Ring growth studies in stumps reveal that this country was frequently burned for at least 296 years or since 1647. Fires have not been so severe nor so frequent since 1848, as suggested by the presence of large number of trees of the 90-year age class. The persistence of groves of oak and Douglas fir, in both pure and mixed stands, in spite of intensive cultivation and the continued burning of the past, suggests that forests of these

[1]Published with the approval of the Monographs Publication Committee, Oregon State College, as Research Paper No. 00, School of Science, Department of Botany.

[2]Department of Botany.

species would occupy most of the valley floor if succession was uninterrupted. South slopes of foothills and knolls would perhaps support limited areas of grassland, because of drainage and exposure.

In the cedar-hemlock formation, western hemlock, western red cedar, and the balsom firs *(Abies grandis, A. amabilis, A. nobilis)* represent the climax dominants. The most abundant tree, however, is Douglas fir which is a subclimax type that has been able to persist in predominance because of recurring fire down through the ages. After fires, this species invades the deforested area, and forms pure, dense, even-aged stands. It is unable to maintain itself, however, because of its shade-intolerence. The climax dominants, whose seedlings thrive on the forest floor, gradually invade and increase in abundance and size. In the meantime, Douglas fir matures and becomes decadent, and is thinned out by insects, disease, windthrow, and lack of reproduction. The more tolerant climax dominants eventually assume predominance, and a stabilized forest of these species develops if fire or lumbering do not prepare the way for a new Douglas fir invasion. A study of the composition of forests of various ages shows that without fire or logging, a Douglas fir forest would be converted to the slimax type in five or six centuries (Munger, 1940). In the Willamette Valley and on the east slope of the Coast Range lying to the west, Douglas fir is probably the climax species, because it is too dry for hemlock and cedar. In this region, the mature Douglas fir forest is not replaced by hemlock even though fire be absent for a few centuries (Munger, 1940). On moister sites, lowland white fir may become predominant.

The purpose of this study was to determine the successional trends in the oak-Douglas fir forest of the Willamette Valley and the adjacent Coast Range foothills. The data for these interpretations have been obtained by a statistical analysis on a representative area. It is possible that the results and conclusions of this study may serve as a silvicultural basis for farm woodland management and grazing practices in this area. Principles of plant succession have been applied successfully in maintaining the desired type of vegetative cover in both forestry and range management. For example, in the cedar-hemlock climax of the Puget Sound region, Douglas fir is a subclimax type as well as the most important commercial species. By clear cutting and providing an adequate seed source as security against subsequent loss by fire, even aged stands of Douglas fir can be obtained. The climax type can be maintained by tree selection cutting (Munger, 1939, Isaac, 1943).

DESCRIPTION OF THE AREA

The area of detailed study lies within the McDonald Forest of the Oregon State College, School of Forestry, at Corvallis. The forest is in Townships 10 and 11 South, Range 5 West, Willamette Meridian. Its area is about 4,800 acres, lying west of U. S. Highway 99W and about 6 miles north of Corvallis. It is representative of the eastern foothills of the Coast Range and the western fringe of the Willamette Valley, where the Coast Range descends abruptly eastward to the Willamette Lowland. The topography has been largely determined by the relative resistance of the Tertiary rocks. The highest peaks are the result of volcanic rocks contemporaneous with or intruded into them. The low mountain range of this section is of Eocene age and probably has never been very high (Fenneman, 1931).

The McDonald Forest includes almost the entire width and 6 miles of the length of a large ridge extending northeast and southwest. The elevations range from 450 to 1550 feet above sea level. In general, the streams and ridges extend northwest and southeast from the main ridge. The study was made on the southwest end of the McDonald Forest in sections 17, 18, 19, and 20; Township 11 South, Range 5 West, in the Oak Creek drainage. At the head

of the creek the canyon sides are steep, grading into gentler slopes southward. Northern exposures are in the minority, with many long, gentle south slopes. Oak Creek flows generally south, resulting chiefly in east and west exposures. The soils of the McDonald Forest are of the Olympic clay and Olympic clay loam series of the Hill Group of residual soils originating from igneous basaltic rocks (Powers, Jones, and Ruzek, 1931).

VEGETATION OF THE AREA

Oregon white oak is the only oak of commercial importance indigenous to the Pacific Northwest. It is a medium-sized tree seldom reaching more than 50 to 75 feet in height and 2 to 3 feet in diameter. Poles of this species are usually short and crooked even when grown under forest conditions. It has a well developed lateral root system and a wide-spreading, round-topped crown, especially in solitary specimens. This tree occurs most abundantly in deep, rich loam in regions where the yearly rainfall does not exceed 30 inches and where humidity is very low during the summer months. Large seed crops are produced every few years but owing to the inability of germinating seeds to penetrate the heavy sods upon which they are disseminated, reproduction from seed is slow. Stump sprouts and root suckers are vigorous, and reproduction is obtained by this means (Harlow and Harrar, 1941).

Its ability to withstand the low summer humidity together with its habit of reproducing readily by root suckers may account substantially for the persistence of Oregon white oak on this area and also helps to explain its aggressiveness in invading grasslands when conditions for seed dissemination and germination are suitable. This species forms distinct fringes around grassland areas with individual trees and small clumps dispersed throughout. These fringes of oak are usually narrow and beyond them is the Douglas fir type with an intermingling of relict specimens of oak becoming decadent or already dead.

Ring growth studies of stumps of these relict specimens show that they grow at a slow rate throughout life. In the coniferous forest these large oaks persist until the forest canopy closes over them, whereupon they rapidly succumb to the intense competition. Pure stands are found particularly on hillsides in this area, seed dispersal apparently being effected when the acorns fall from the trees and roll downward. Possibly rodents are also instrumental in seed dispersal.

Douglas fir grows in a variety of soils, and on the McDonald Forest site conditions range from the poorest to the best for this species. In youth, Douglas fir forms extensive, pure, even-aged stands. Anchorage is provided by a well-developed, wide-spreading lateral root system. Seed is produced in abundance after the twenty-fifth year. Heavy seed crops are produced at intervals of two or three years. Crowns of this species are very inflammable and fire is its worst enemy (Harlow and Harrar, 1941).

On the area covered in this study there is a large number of old, open-grown trees of the "wolf tree" type which provide seed. These may not be exexpected to seed the surrounding areas effectively at greater distances than 300-400 yards (Isaac, 1930, 1943). It is from old trees of this type that growth ring studies have been made revealing the past fire history of the area. Because these trees are, in general, so widely scattered over the area, the effective range of seed dispersal of the individual trees does not overlap that of its neighbor and patchwise stands result. In many cases these patches or islands of Douglas fir timber are normally stocked stands producing good quality timber. Natural pruning is progressing satisfactorily. On the other hand, there are areas on which physical features have precluded the uniform germination and establishment of seedlings; therefore, poorly stocked stands are the result.

Bigleaf maple occurs singly or in small groves associated with the other timber species of this area. It is more abundant near the creek bottoms in the better quality soils. Long clear boles and narrow crowns are developed under forest conditions. When open grown the trunk breaks up into several ascending branches to form a globose crown. The root system is shallow and wide-spreading (Harlow and Harrar, 1941). This tree seems much more tolerant under forest conditions than oak.

Grand fir or lowland white fir, like bigleaf maple, is found principally on flood plains and gentle slopes on the area studied. As a rule it occurs singly but it is not uncommonly found in groups or small pure stands. Young trees are quite tolerant and have been found on this area forming dense thickets of sapling-sized trees. Older trees usually have long spire-shaped crowns and in maturity the crown becomes more dome-shaped. The root system is deep and spreading (Harlow and Harrar, 1941).

The four species described above are the principal forest trees in this area. Other species of lesser importance in the forest are widely scattered or concentrated on flood plains, and in ravines and gorges, depending upon each species' individual requirements. Red alder is the main species on the flood plains with willow *(Salix spp.)* in association. Red-stemmed dogwood *(Cornus stolonifera)* and some Oregon ash *(Fraxinus oregona)* occur also on flood plains. Western yew *(Taxus brevifolai)* and flowering dogwood *(Cornus nuttalii)* inhabit the moister aspects and steep canyon sides. Scattered over the more exposed slopes and occuping similar sites are black haw *(Crataegus douglassi)*, Madrona *(Arbutus menziessi)*, the bitter cherry *(Prunus emarginata)*, and cascara *(Rhamnus purshiana)*.

The more predominant shrubby species of the area are thimble berry *(Rubus parviflorus)*, snow-berry *(Symphoricarpos albus)*, salal *(Gaultheria shallon)*, and poison oak *(Rhus diversiloba)*. A plant commonly invading the grasslands in advance of the tree growth is the common wild rose *(Rosa rubiginosa)*. This invasion ranges from a few clumps per acre to as high as an estimated 20 per cent of the area. Under the shade of the forest canopy sword-ferns *(Polystichum munitum)* are numerous. In the more open areas bracken fern *(Pteridium aguilinum)* often forms a dense ground cover. St. John's Wort *(Hypericum perforatum)* is prevalent on some grassland areas and is very undesirable from the standpoint of forage value and its effect on the grassland vegetation.

EFFECTS OF LOGGING AND BURNING

As a result of logging and burning, forests on parts of the area have undergone retrogression. The young growth Douglas fir was heavily cut during 1915-1920, and although appearance of the remaining stumps indicate light burning, these patches now support an extremely dense cover of brushy species. Ostensibly this heavy ground cover precludes establishment of Douglas fir reproduction except by gradual encroachment from the edges of these brushlands. Such conditions, however, seem to represent the extreme condition.

Other tracts have been reforested extensively but from a forestry point-of-view they are not fully stocked with any one species or combination of species. The trees on these areas are therefore open-grown and limby. However, more extensive areas adjoining these brushlands and open Douglas fir is advancing beyond the previous peripheries of the coniferous timber. This apparently is encouraged by the protection from summer desiccation afforded by the shade of the oaks. Abandoned farms are being invaded by Douglas fir and oak, especially the former, because of the adjacent uncut Douglas fir timber.

Grazing has been permitted, and the most obvious damage to the vegetation has been trampling along the fence rows. This, however, is not extensive enough to be of any economic conse-

quence. Grazing has been light and browsing damage is barely noticeable. During a heavy snow in January 1943, sheep browsed Douglas fir seedlings that extended above the snow. No other green feed was available at the time. Where sheep have been concentrated for some time on an area, regardless of weather conditions, there are indications that they have browsed Douglas fir seedlings. Browsing on oak is not as noticeable nor as extensive.

Moles and ground squirrels are abundant and their mounds are numerous and widespread. Disturbance of the soil may afford suitable seed beds for germination of tree seedlings. On the other hand, the exposure of seeds on the mounds probably favor their destruction by seed-eating animals.

METHODS AND RESULTS

One hundred sample plots, 25 feet square, were taken, well distributed over the area. In order to maintain an unpredjudiced sample plot distribution, a box asimuth compass was used, and the plots established at 3-chain intervals except where no trees were present. In such cases, the distance between the plots was adjusted to fit the pattern of the forest stands. This was felt to be justified, because the study is concerned with the arboreal vegetation rather than the vegetation as a whole. Where a line folowed a fence, plots were established one-half chain distance from the fence to avoid the influence of tree cutting when the fence was constructed, as well as the trampling and browsing by stock. All trees were measured at breast height, and those under 1 inch in diameter were counted as small trees or seedlings. Stumps were measured at stump height. Growth ring counts were made of both oak and Douglas fir and the diameters were also measured.

The data are presented both in tubular and graphical form. The graphical presentation is affected by means of phytographs (Lutz, 1930). The method consists of constructing a polygonal figure formed on four axes representing what are considered to be the most important criteria for characterizing the ecological position of a tree species in a forest association. The four criteria selected were: (1) abundance, i.e., the number of trees of a given species represented as a per cent of the total number of trees of all species 1.0 inch DBH and over; (2) frequency, i.e., the number of sample plots in which are found one or more trees 1.0 inch DBH or over of a given species expressed as per cent of total number of sample plots; (3) number of size classes in which each species is represented; and (4) basal area of each species expressed as per cent of total basal area of these four quantitative factors for each species in the same graph give an integrated picture of the relationships among the several measurements. The mass effect portrays the relative importance of the several species concerned.

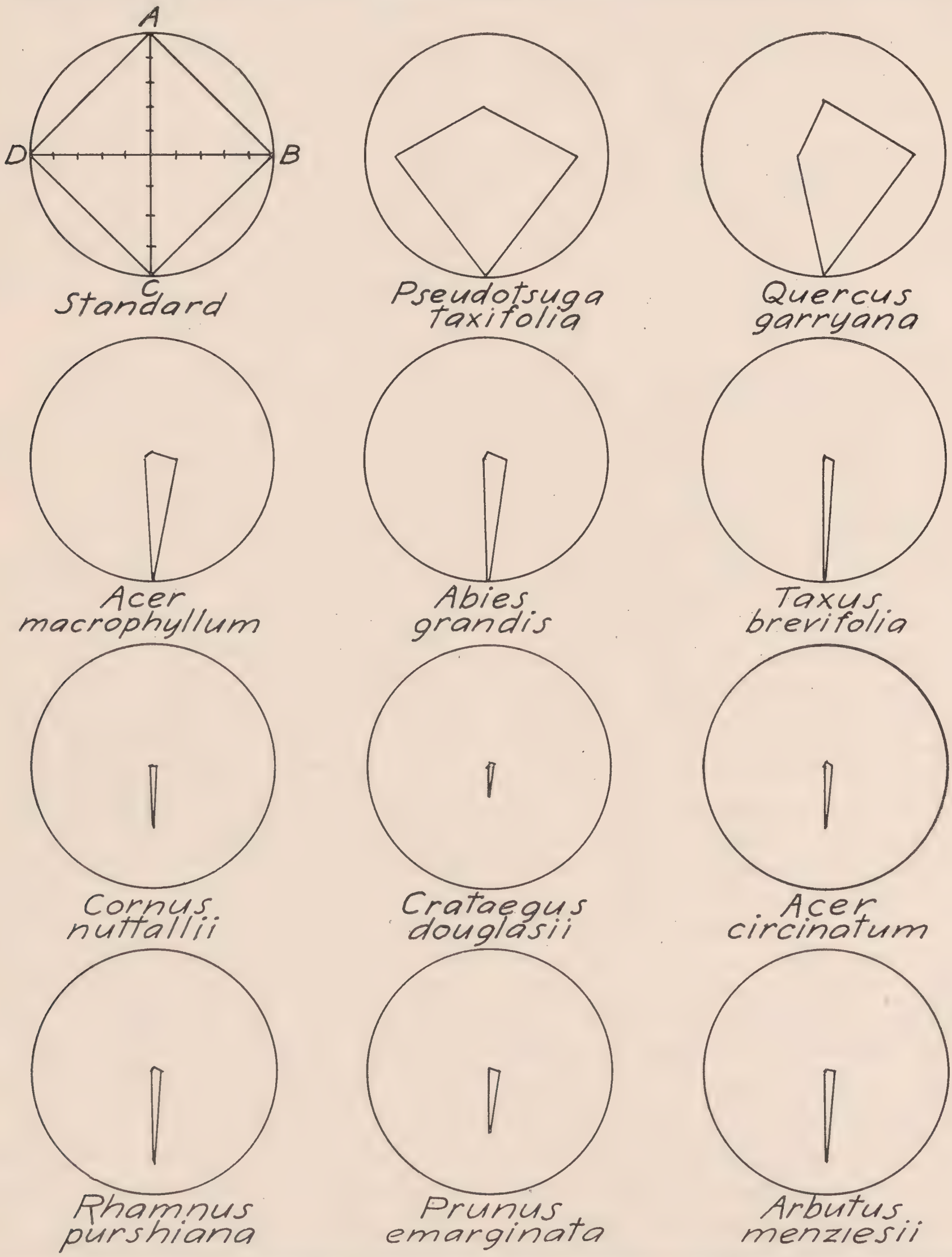
INTERPRETATION OF DATA

Ring growth studies of oak and Douglas fir stumps show the growth rate of the latter species to be from 3 to 5 times that of oak. It has been pointed out earlier that oak precedes Douglas fir on most of the area, particularly those areas that were previously grassland. These facts account for the greater number of oaks 1.0 inch DBH and over. There is a wide difference in the basal area of the oak and Douglas fir; that of the latter being about four times that of the oak (figure IV). This is further evidence of the more rapid growth by Douglas fir. However, about one-third of the basal area of Douglas fir represents stumps left from logging. On this area the Douglas fir was still of a comparatively small size when clear cut and had not yet completely crowded out the scattered old oaks. From this seed source oak reproduction has become established, particularly on the more exposed sites. This accounts for the abundance of small oaks on areas that were previously forested by Douglas fir. The frequency of oak and Douglas fir is nearly the same, the latter being found in six more sample plots than the oak (figure II). The reason for this is

that some sample plots were taken on north slopes where the oak has long been crowded out and also pure stands of older Douglas fir contained only widely scattered relict oaks.

Bigleaf maple trees are fewer in number but higher in frequency than lowland white fir, indicating that bigleaf maple is more uniformly distributed. The lower frequency of the lowland white fir is probably due to reproduction being more or less concentrated near seed sources. However, lowland white fir has gained a substantial foothold from the standpoint of abundance of trees 1.0 inch DBH and over (figure III). Except for a few suppressed trees of small size, lowland white firs are vigorous and competing strongly for their places in the forest canopy.

Figure 1. Phytographs for the arboreal species in the McDonald forest.



OA, per cent of total abundance; OB, frequency; OC, per cent of four size classes represented; OD, per cent of total basal area.

Figure III shows a significant relationship between the various species and the number that is represented in each size class. In general the forest growth is open enough to permit germination of Douglas fir seed. This is shown in the table by the large number of Douglas fir seedlings. These seedlings are more heavily concentrated on areas where an over-story of oak existed with a Douglas fir seed source in the immediate vicinity. This was particularly true on south slopes. A careful count on one sample plot with a southwest exposure revealed 94 Douglas fir trees under 1.0 inch DBH. On open areas having scattered single oaks or clumps, the Douglas fir reproduction is concentrated on the northeast side of the oaks. These clumps of reproduction are well defined with none or only an occasional seedling outside the areas covered by the shadow cast by the oak tree during the hottest part of the afternoon. This indicates that the partial shade cast by the oaks or other species prevents desiccation and is responsible for the establishment of Douglas fir seedlings. Where heavy brush or dense forest conditions are not encountered and an adequate seed source is present, small Douglas fir reproduction is generally abundant. It is in the dense forest situations that lowland white fir is gaining a foothold.

While lowland white fir is not so well represented by abundance in the larger size classes, it does show a comparatively large number of small trees less than 1.0 inch DBH. This reproduction was found under dense forest conditions and this fact is indicative of the species' ability to reproduce under denser shade than Douglas fir. On this area, Douglas fir reproduction was not found under as low light intensities as lowland white fir.

Figure IV, showing the basal area of dead trees and stumps, is rather misleading for lowland white fir. Two

Figure II. Data from sample plots for trees 1.0 inch DBH and over.

Species	Abundance No.	Abundance Per cent	Frequency Per Cent	Size Classes	Basal area in sq. ft. BA	Basal area in sq. ft. Per cent
Pseudotsuga taxifolia	378	40.2	76	4	242.7	72.7
Quercus garryana	420	44.5	71	4	62.6	18.7
Acer macrophyllum	40	4.3	20	4	17.0	5.1
Abies grandis	60	6.3	15	4	5.9	1.7
Cornus nuttallil	2	0.2	1	2	1.7	0.6
Crataegus	2	0.2	1	1	0.0	0.0
Acer circinatum	4	0.4	1	2	0.1	0.0
Taxus brevifolia	7	0.8	4	4	2.5	0.8
Rhamnus purshiana	7	0.8	3	3	0.0	0.0
Prunus emarginata	11	1.1	3	2	0.0	0.0
Sailx sp.	1	0.1	1	1	0.0	0.0
Arbutus menziesii	11	1.1	3	3	1.1	0.4
Totals	943	100.0			333.6	

Figure III. Number of trees in each size class.

Species	Under 1"	1.0"-3.0"	3.0"-10.0"	10.0" and over
Pseudotsuga taxifolia	598	94	154	130
Quercus garryana	85	181	220	19
Abies grandis	170	38	18	4
Acer macrophyllum	3	12	19	9
Cornus nuttalli			1	1
Crataegus douglasii		2		
Acer circinatum	8	3	4	
Taxus brevifolia	11	1	1	2
Rhamus purshiana	8	7		
Prunus emarginata		3	8	
Salix sp.	1	1		
Arbutus menziesii	6	4	6	

large stumps were found on one plot which raised the proportion of dead trees or stumps to nearly one-half of the total basal area. This same consideration must be applied to the analysis of the data for Douglas fir for which both basal area and number of trees 10 inches DBH and over are high because of the large number of stumps on the area. Therefore, practically all of the basal area representing the dead trees of this species consists of stumps and is not a result of decimation by natural causes. On the other hand, 13.9 per cent of the total basal area of Oregon white oak represents dead trees with only one stump measured on the area. These oak trees have died from natural causes and especially heavy competition from the faster growing conifers. Most of these dead oaks were of the smaller size classes.

The greatest number of oaks is in the two size classes from 1.0 inch to 10.0 inches DBH indicating the slow growth of the species and the probable establishment of the oak stand following the

Figure IV. Per cent of total basal area in square feet represented by stumps and dead trees.

	Total basal area	Basal area of stumps and dead trees	Per cent basal area of stumps and dead trees
Pseudotsuga taxifolia	242.7	85.8	35.7
Querucs garryana	62.6	8.7	13.9
Abies grandis	5.9	2.9	49.1
Acer macrophyllum	17.0	0.3	1.7

1915-20 logging. These size-classes are particularly prevalent on the areas that are represented in all four size classes are Douglas fir, Oregon white oak, bigleaf maple, lowland white fir, and western yew. The latter two species reproduce under dense shade if other conditions are suitable.

APPLICATION TO MANAGEMENT

Economically this area is producing neither forage nor timber to its greatest capacity. To bring the land into maximum timber production within a reasonable period of time would require extensive planting, the success of which would be doubtful, especially on the south and southwest exposures. It would seem practical to manage the existing stands of Dolglas fir for permanent timber production. Where this reproduction is entirely under the shade of the older oaks and has become well enough established, the oaks should be harvested.

Those areas best suited topographically to forage production, south slopes in particular, should have some range improvement work done on them. Rose bush eradication on this area would probably constitute a major expense item along with preparation of the soil and sowing the area to a good mixture of range plant species. At the same time the carrying capacity of the range would be greatly increased.

It is believed, however, that if the area is disturbed by only moderate grazing, it will eventually support a commercial stand of coniferous timber. On the other hand, if intensive range improvement is done, the normal succession toward tree growth may be halted for an indefinite period.

SUMMARY

One hundred sample plots were taken on the McDonald Forest in the Willamette Valley of western Oregon to determine the arboreal successional trend of a white oak-Douglas fir community. This area has been logged and burned over, resulting in some forest retrogression. The vegetation varies from grass and brush to oak and Douglas fir each in pure stands or with the two species in association. It was found that the greatest number of "seedlings and small trees" consists of Douglas fir, while the greatest proportion of trees 1.0 inch DBH and over is of white oak. The greatest concentration of lowland white fir seedlings and saplings was found to occur in the dense forest and near the original seed sources. Previously non-forested areas are being invaded by white oak, which is closely followed by Douglas fir. The absence of white oak and Douglas fir reproduction under the dense forest canopy and the abundance of lowland white fir under these same situations indicate a successional trend of white oak to Douglas fir followed possibly by a climax forest of lowland white fir, or a Douglas fir-lowland white fir association. This is further suggested by the presence of relict oaks in the dense Douglas fir stands.

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ABSTRACTS OF PAPERS DELIVERED BEFORE THE GEOLOGY-GEOGRAPHY SECTION, DECEMBER 27-28, 1945

CONTRIBUTIONS TO THE GEOLOGY OF NORTHWESTERN STEVENS COUNTY, WASHINGTON

CHARLES D. CAMPBELL

State College of Washington[1]

Areal geologic mapping east of Columbia River in northern Stevens County indicates that the formations there may be correlated with certain of those in the Metaline quadrangle immediately to the east. Fossils were found in the Ledbetter slate and Metaline limestone, but most of the correlation had to be based upon similarity of lithologic sequences. The stratigraphic section follows:

FORMATION NAME	AGE	APPROXIMATE THICKNESS
Ledbetter slate	Ordovician (middle)	not determined
	Disconformity?	
Metaline limestone	Cambrian (lower middle)	6100
Maitlen phyllite	Cambrian (lower?)	over 3700
Gypsy quartzite	Cambrian (lower?)	over 2500
	Base faulted down	
Kaniksu granitic batholith	Cretaceous?	

Four swarms of andesitic dikes may be offshoots of the Kaniksu batholith.

The beds form steep-sided folds that trend northeast. Some folds are overturned to the northwest, and two reverse faults that dip southeast were seen. Of the many high-angle faults, ten appear to exceed 2000 feet in vertical displacement. Of the ten, all but one strike northeast, and at least two are vertical.

The folding and reverse faulting took place probably between the Carboniferous and Cretaceous periods, and the high-angle faulting during the Tertiary, or late Cretaceous.

GEOLOGY OF THE FOSTER CREEK DAM SITE

ALLEN S. CARY

U. S. Engineering Department, Seattle District[2]

The Foster Creek Dam Site, 50 miles downstream (west) from the Grand Coulee Dam, is designed to utilize 165 feet of head between Coulee and the Foster Creek Rapids in the Columbia River. The south bank and river bed at the site are excellent granite foundation for the dam, powerhouse, and all appurtenant works. The north bank is all glacial debris above the nearly level bedrock valley floor and nearly all pervious below pool level. Two methods of controlling seepage through the north bank are being considered. First, a concrete cutoff wall extending 2600 feet to intercept bedrock at pool level; and, second, an impervious blanket on the exposed surface of the previous material upstream from the dam coupled with a partial cutoff wall into the previous material.

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ENGINEERING GEOLOGY — A GROWING SCIENCE

ADE E. JASKAR
U. S. Engineering Department, Seattle District[1]

The growth of the science of engineering geology in the last two decades is remarkable. Contributing factors to its growth are the increase in the number of agencies using geologists, the increased scope of civil engineering, the fact that engineering projects are becoming more complex, and the development of mental and physical tools to translate geologic features from scientific language into more useful data. Civil engineering projects in the Northwest demonstrate the new applications of geologic knowledge. Academic studies of Northwest geology will be stimulated by the results of engineering geology investigations.

REACTION RIMS ON QUARTZ INCLUSIONS IN A DIABASE DIKE

G. E. GOODSPEED
University of Washington[2]

One of the numerous Tertiary diabase dikes of the Wallowa mountain region occurs along the southern extension of the Wallingford vein in the vicinity of Cornucopia, Oregon. It differs from the similar dikes in that it is filled with rock and quartz inclusions. Although the country rock in the vicinity of the outcrop consists entirely of granodiorite the dike conains inclusions of siliceous hornfels as well as granodiorite, quartz and feldspar grains derived from the granodiorite and vein quartz fragments. These fragments range in size from small grains a fraction of an inch in diameter to large angular pieces several inches to a foot in size.

The smaller quartz grains are surrounded by a brownish rib which under the microscope is seen to consist of pyroxene crystals for the most part augite. These crystals are commonly at right angles to the peripheral surface of the quartz grain, and some of them extend into the quartz and form slightly enlarged peg-like heads, and are separated by thin septa of quartz. Some of the quartz grains are also embayed by aggregates of zeolites which were formed presumably during the last stages of consolidation of the volatile-rich fraction of the magma. The reaction rims around the quartz inclusions in this dike appear to have resulted from an earlier magmatic metasomatic replacement which was followed by a later deuteric corrosion and replacement.

PRELIMINARY STUDY OF TEXTURES AND STRUCTURES IN THE GRANIDIORITE AND ASSOCIATED SCHISTS AT FOSTER CREEK DAM SITE

ARTHUR W. SCHMIDT
U. S. Engineering Office, Seattle, Wash.[3]

The rock at Foster Creek Dam Site consits of granodiorite in gradational contact with biotite-hornblende-quartz schist, and includes numerous large irregular tabular masses of schist and transitional schistose or gneissic facies.

The crystalloblastic character of the rock, the continuity of relic schistosity through granodiorite and transitional facies in graduational contact, and the similarity of small mineral crystals included in large porphyroblasts, usually in relic alignment or helizitic structure, support an hypothesis of metamorphic origin of the granodiorite by the metasomatic processes of granitization and feldspathization of biotite-hornblende schist.

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GEOLOGY AND GEOGRAPHY OF EUGENE AND ITS TERRITORY

WARREN D. SMITH
University of Oregon[1]

Eugene is the county seat of Lane county—one of the few counties in the United States which extends from the summit of a mountain range (over 10,000 feet high) to the ocean. It is in a unique position geographically as it lies near the junction of several tributary valleys of the Willamette River, giving it a very unusual strategic position with reference to the business of the Upper Willamette Valley. At the present time, Eugene is the virtual lumber capital of this country and just now is changing rapidly from an adolescent city to a mature one and is enjoying a mild boom. It is virtually near the transportation center of the state.

This paper discusses first the physical basis as a background for the activities of this city. This includes a general survey of Lane county especially, and the country even beyond the confines of this county. This is followed by a short survey of the history of the city from its founding by Eugene Skinner in 1857. The geological foundation is next discussed, and a chart presented which shows schematically the relation between the various activities of this region to the geological foundation. Next, the climate and physiography are discussed in detail and a special section is devoted to the Willamette Flood Project in which five of the seven flood control dams are to be located in the immediate vicinity of Eugene. The completion of this project will profoundly influence the economy of this region.

The second part of this study is devoted to a detailed discussion of the city itself, with the usual topics such as site, functional differentiations, street pattern, types of buildings, internal transportation, public utilities, health and sanitation, etc.

The third part will deal with economic resources of the region: the major industries, lumber, agriculture, and some reference to the mining nidustry, followed by education, recreation, etc.

The fourth part is devoted to a discussion of Eugene prospects for the future with suggestions for planning.

As Eugene is now embarking upon a study for a master plan, a study of this kind may be of some assistance, and may sugggest how similar studies of other urban areas in Oregon may be carried out.

GEOLOGY OF THE AREA BETWEEN THE SNAKE AND SALMON RIVERS NORTH OF RIGGINS, IDAHO

WARREN R. WAGNER[2]

This report presents the preliminary results of the writer's field work for the Idaho Bureau of Mines and Geology during the months of June and July, 1944 and a few days during August of 1945.

The oldest rocks of the area are the green volcanics of the Seven Devils series. These are unconformably overlain by Upper Triassic limestones, phyllites and phyllitic schists. After deposition of the Triassic beds, the rocks of the area were uplifted, folded, faulted, intruded by granitic stocks, and then eroded to a mature surface. The Columbia River basalt of Miocene age then poured out on this mature erosion surface. Following the extrusion of the basaltic lavas the area was uplifted, warped and faulted. One large fault, called the Salmon River fault because it controls the direction of the Salmon River between the towns of Whitebird and Lucile, Idaho, offsets the flows of Columbia River basalt, making a tilted block of a part of the plateau surface.

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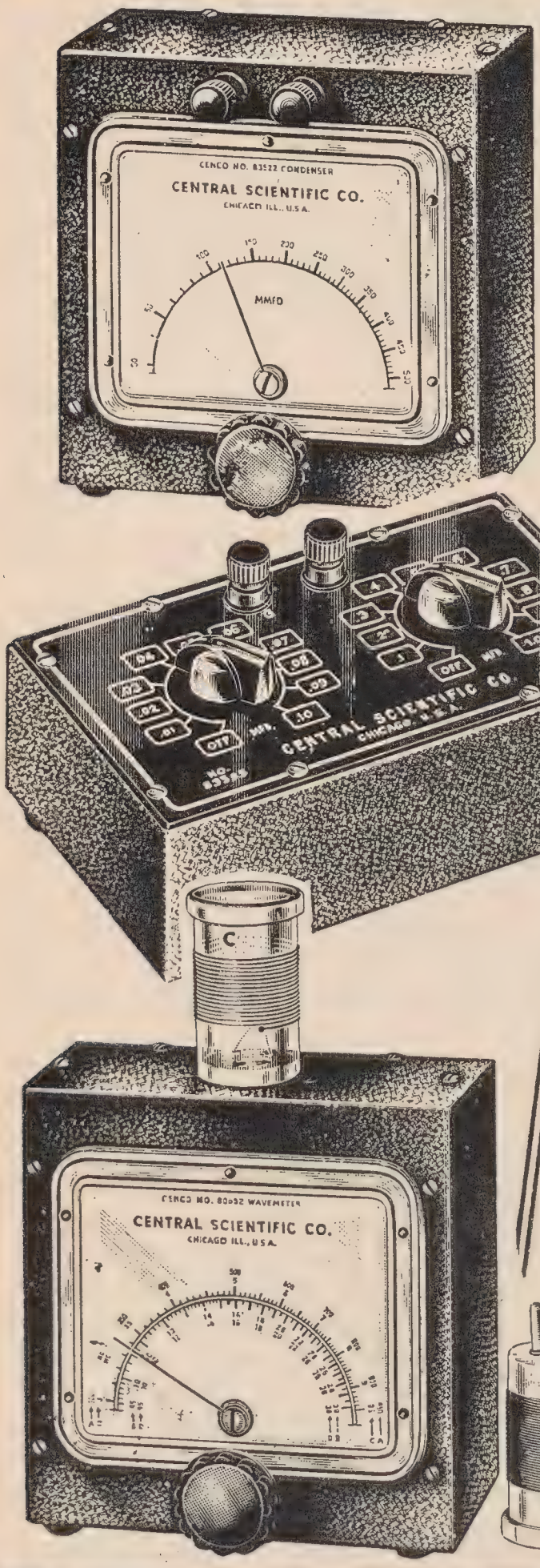

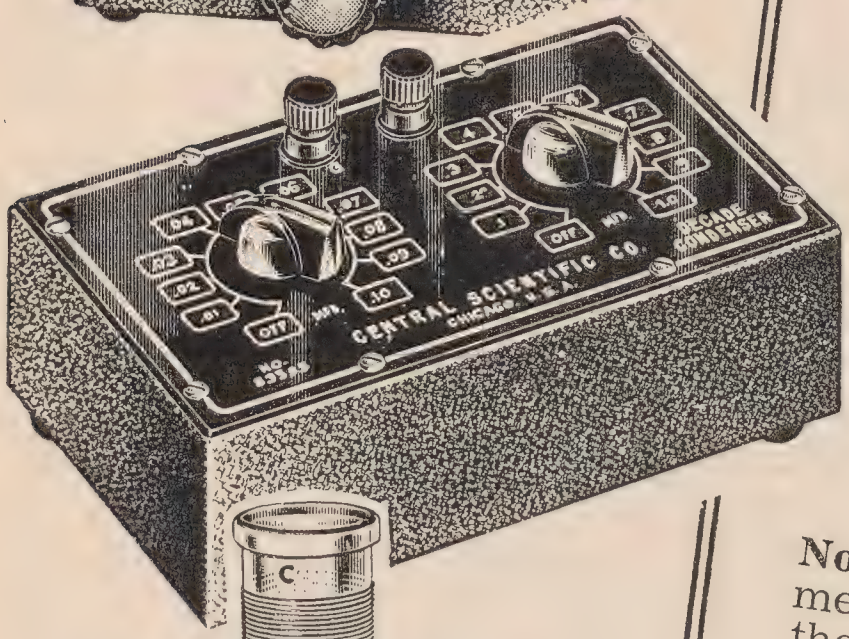

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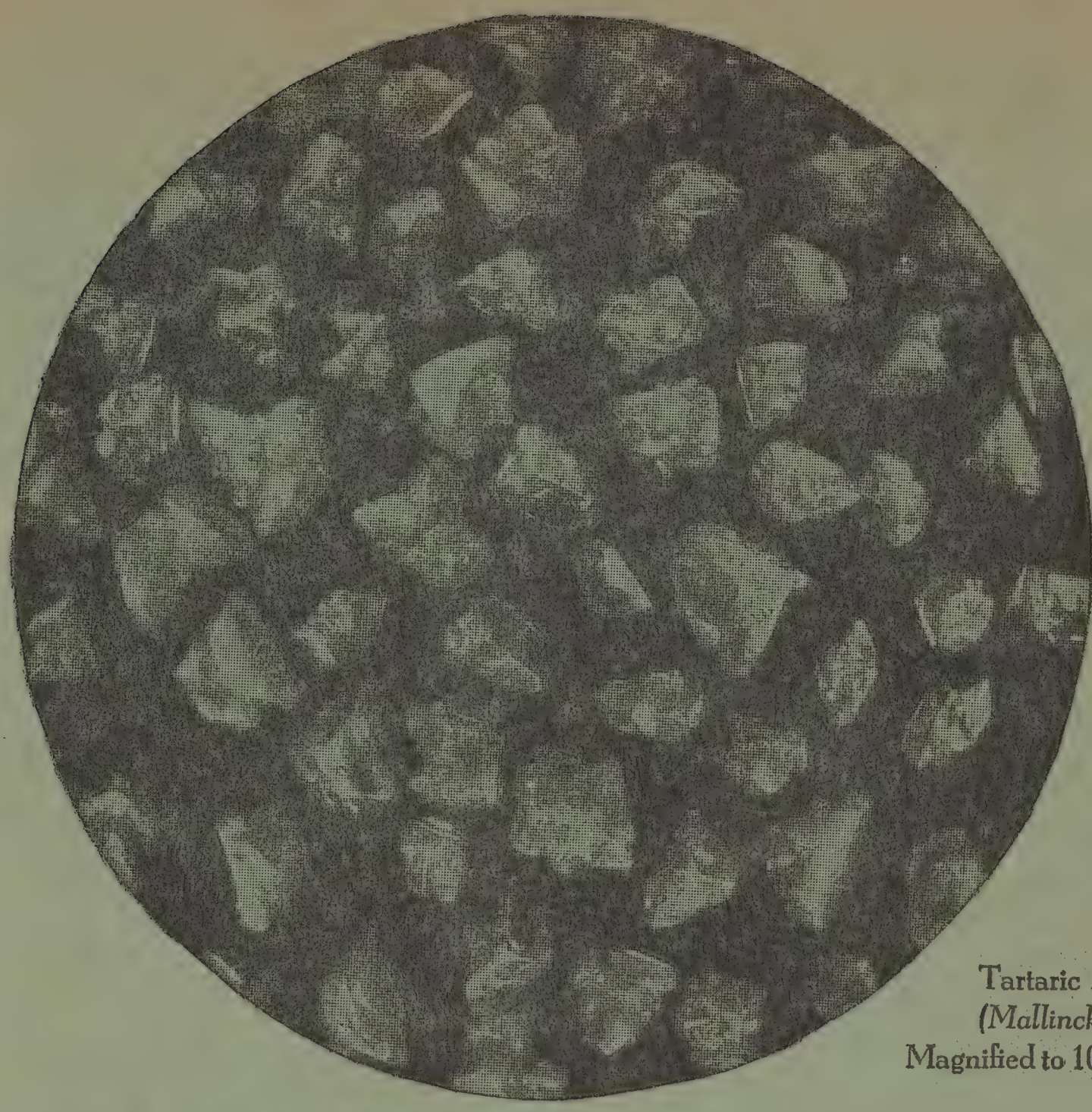

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